Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

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Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

NOVEMBER, 1914.

THE PLANET JUPITER.

By THE REV. THEODORE E. R. PHILLIPS, M.A., F.R.A.S.

THOUGH lacking in those special features which, in the popular view, invest Mars with such an atmosphere of romance, Jupiter, nevertheless, claims in an equal degree the close attention of telescopic observers. Indeed, to the amateur whose optical resources are usually of a modest nature, Jupiter affords a far more profitable field for work than Mars, whose small disc only now and again presents developments on a sufficiently large scale to be well within the grasp of small apertures. Such a development on Mars has occurred in recent years in the Nepenthes, L. Moeris, and Thoth region; but, broadly speaking, it may be said that, even in large instruments, the approximately stable features of the smaller and more condensed planet cannot, in the nature of things, present constant and unexpected changes, such as demand the watchful attention and assiduous work of the observer of Jupiter.

As regards physical condition, it has long been recognised that Jupiter has many points of analogy with the Sun. Its density is the same, and it is generally inferred that, like the Sun, it is in a heated and expanded condition, and that, if not still partially gaseous, it is, at any rate, in a viscous and semi-liquid state. Many features, too, of superficial resemblance have been pointed out by various investigators. To refer to two of the more striking and obvious instances, we may mention: (1) The analogy between the spot-zones on the Sun and the belts on Jupiter; and (2) the equatorial acceleration of both bodies.

As regards the first of these, it has been suggested by Lau (*Astron. Nachrichten*, Band 195, No. 4673) that the reason Jupiter has belts instead of zones of spots is to be found in its rapid rotation. The material forced upwards from the lower strata of the planet, bringing with it a smaller linear velocity than that of the surface, streams eastwards and assumes the appearance of elongated streaks. If the centres of eruption are sufficiently numerous, belts are formed; and it is suggested that, were the Sun's rotation much more rapid than it is, the solar surface at spot maximum would also present dark streaks or belts.

In accordance with this theory of belt formation it will be remembered that the great revival of Jupiter's north equatorial belt in 1912–13 began with the outbreak of a few isolated dark spots, which quickly spread out round the planet.

As regards the second of the analogies above-mentioned, it will be recalled that the rotation of the Sun can be fairly represented by a simple empirical formula, the velocity being related to the latitude and diminishing from the equator towards the poles. Now Cassini, in 1690, found that a spot on the equator of Jupiter required about five minutes or so less for a rotation than an object in the southern hemisphere; and subsequent observations have established the existence of

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a rapid equatorial current as a permanent feature of the visible surface of the planet. It is true that the cases of Jupiter and the Sun are not quite the same; on the former there is no general increase in the rotation period with increasing latitude, but a sudden and abrupt change in the velocity in both hemispheres at about latitude seven degrees. The equatorial current of Jupiter is therefore like a mighty river sharply bounded by two banks which are usually indicated by the two great equatorial belts.* Beyond these the arrangement of the currents is unsymmetrical and dissimilar in the two hemispheres; but, notwithstanding these differences, the analogy between the equatorial accelerations of the Sun and Jupiter is very striking, and it is hardly possible to doubt that the cause in each case is the same.

It is not intended in this article to discuss in any detail the physics of Jupiter, but the analogy, to which attention has been drawn between the planet and the Sun, suggests certain possible explanations of some of the planet's phenomena.

(*a*) It has been found that certain sunspots appear to be vortices, and exhibit a whirling motion. It is suggested that many of the Jovian spots are of the same nature, and are the results of disturbances whose origins lie at some depth below the superficial layers. Kritzinger (see *B.A.A. Journal*, Vol. XXIV, No. 9) thinks it probable that, in accordance with Emden's theory of the sunspot zones, a number of discontinuous surfaces are developed within the planet, and that the edges of these different surfaces at the boundary of the disc produce the belts. The effect of two terrestrial atmospheric layers of different density, with one gliding over the other, in producing clouds of the cirro-cumulus type is well known, and it is hinted that the Jovian spots have an analogous formation. Lau also (*Astron. Nachrichten*, Band 195, No. 4673) considers that vortices are formed along the line of contact between the great equatorial current and the slower moving material north and south.

It is now very generally held that the Great Red Spot is a vortex. That it is not a solid feature of the planet is proved by its extensive wanderings, but at least it is sub-permanent, and has indicated a centre of disturbance which has existed certainly for over eighty years, as Denning and Kritzinger have independently shown, and probably for over two hundred and fifty years. The idea that the Red Spot is a vortex is well supported by the behaviour of the dark material forming the South Tropical Disturbance, or "Schleier," which has been so prominent a feature of the disc during the last thirteen years. Six times has the Disturbance, which is situated in the same latitude as the Red Spot, overtaken the latter, and its behaviour at such times, though still in some respects mysterious, is nevertheless instructive. Now it has been observed that, as the *p* end of the Disturbance approaches the *f* "shoulder" of the hollow, it becomes accelerated, but that after its appearance west of the *p* "shoulder" it is retarded. The same thing is true of the *f* end. This is strongly suggestive that the Red Spot is a centre of attraction, a vortex which draws into itself the surrounding material. It is, however, not certain at what level the Disturbance moves. Lau considers that it passes under the white material overlying the Red Spot, and certainly little or no trace of it is seen during its passage across the bay. On the other hand, the outline of the Spot itself has sometimes been faintly discerned during conjunction, which suggests that the dark matter is mostly whirled round the periphery of the vortex and passes out on the *p* side. It has been observed that the time occupied in passing from the *f* to the *p* "shoulder" by the ends of the Disturbance is very decidedly shorter than the time usually required to move over the same distance elsewhere. The vortex theory also explains the formation of the bay, or hollow, in which the Red Spot lies; since the drawing in of matter towards the centre at the lower levels must be accompanied by an outward flow at a greater altitude. This latter may very well drive back the material of the south equatorial belt, and consequently give rise to the formation of the well-known bay at its south edge.

(*b*) The equatorial acceleration of Jupiter, like that of the Sun, presents an interesting problem. Lau, in his article above referred to, speaks of it as a survival from an earlier condition of things, and apparently considers that it has its origin in the falling in of particles possessing a greater angular velocity than the planet itself. Whether the combined momentum of such particles would be sufficient now to produce an appreciable effect may be questioned; but, if the masses of the planets and the Sun have been in the past much increased by the accretion of meteoric dust particles revolving in direct orbits, the tendency would certainly have been to produce an accelerated superficial equatorial motion. A simple calculation shows that particles revolving close to the Sun's surface would perform a revolution in, roughly, three hours, whereas the Sun itself requires for a rotation at least twenty-five days. For particles one hundred miles above the present surface of Jupiter, and spots on the Jovian equator, the corresponding times are 2h 57m and 9h 50m respectively. The same kind of thing is true of Saturn; and it seems quite possible that we have here, at any rate, one factor in the production of the equatorial acceleration exhibited by the larger bodies of the solar system.

A point which has attracted the close attention of observers of Jupiter is the variation in the

* The southern line of demarcation is usually between the two components of the south equatorial belt. In the northern hemisphere it is commonly at the north edge of the north equatorial belt, though when that belt is broad and double it often lies between the two components.

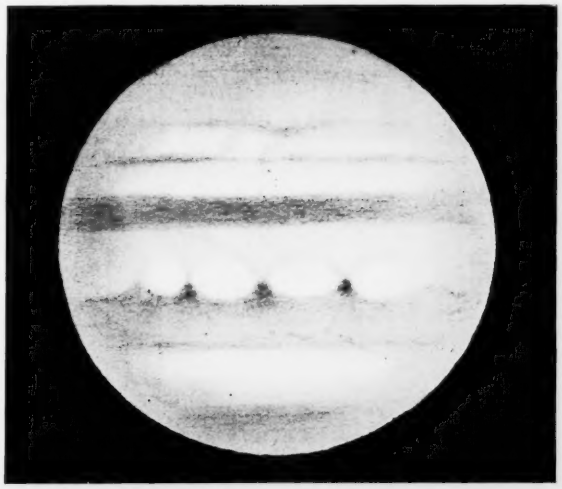

FIGURE 363. July 24, 1913. $\lambda_1=55°$. $\lambda_2=82°$.

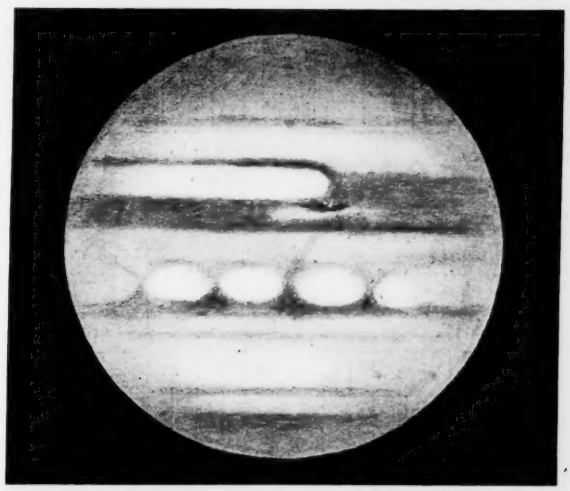

FIGURE 364. August 28, 1913. $\lambda_1=60°$. $\lambda_2=181°$.

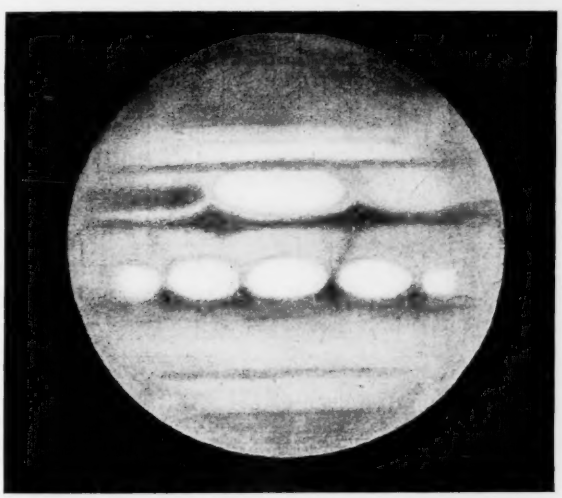

FIGURE 365. September 12, 1913. $\lambda_1=252°$. $\lambda_2=259°$.

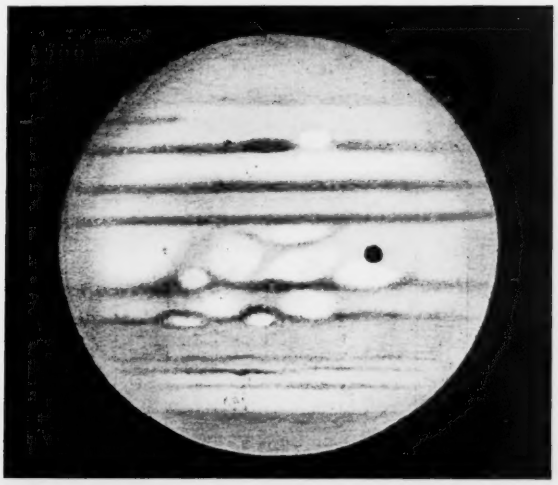

FIGURE 366. August 23, 1914. $\lambda_1=78°$. $\lambda_2=358°$.

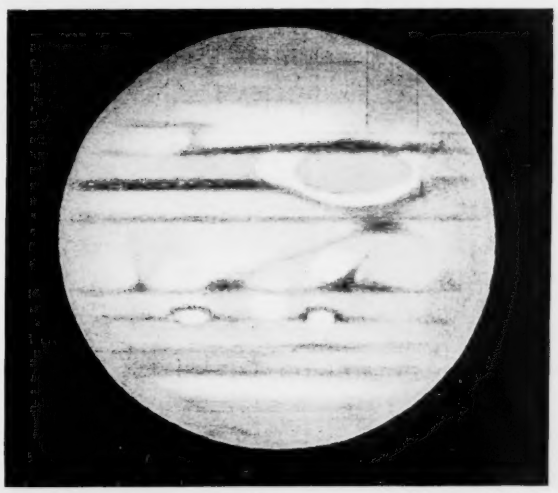

FIGURE 367. August 29, 1914. $\lambda_1=336°$. $\lambda_2=184°$.

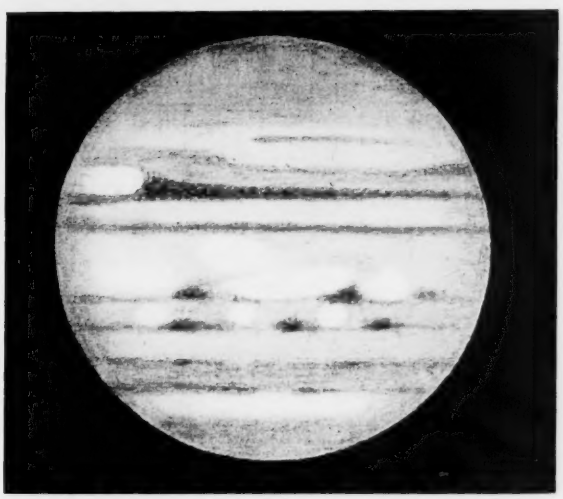

FIGURE 368. August 31, 1914. $\lambda_1=270°$. $\lambda_2=103°$.

The planet Jupiter as seen in an Inverting Telescope.

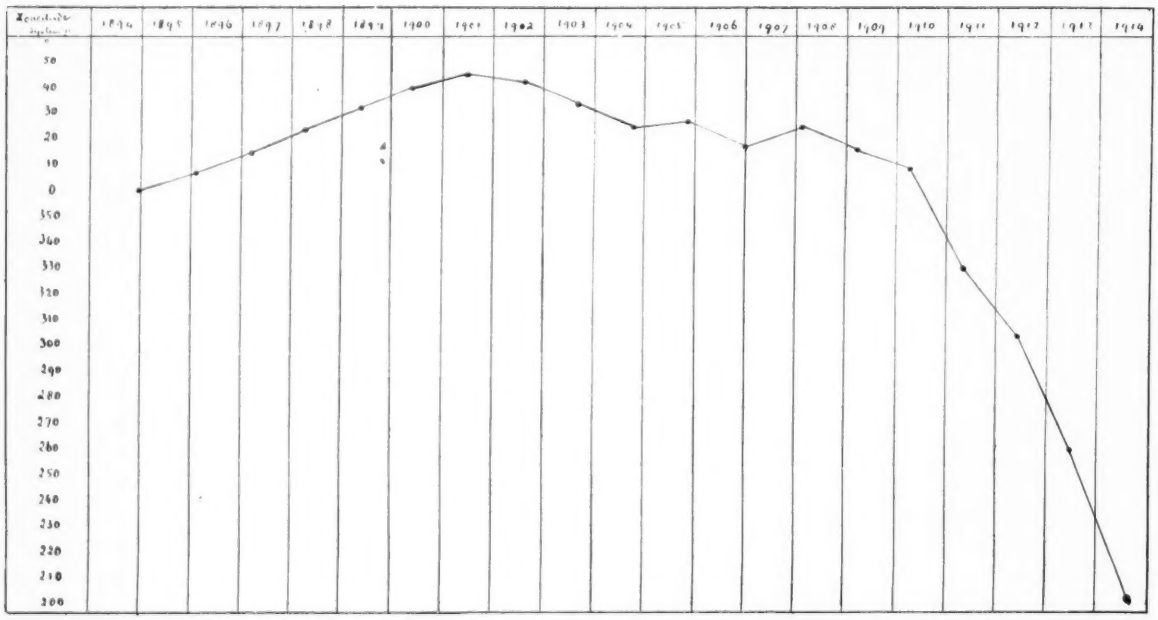

FIGURE 369.

Position of Red Spot at opposition, 1894 to 1914.

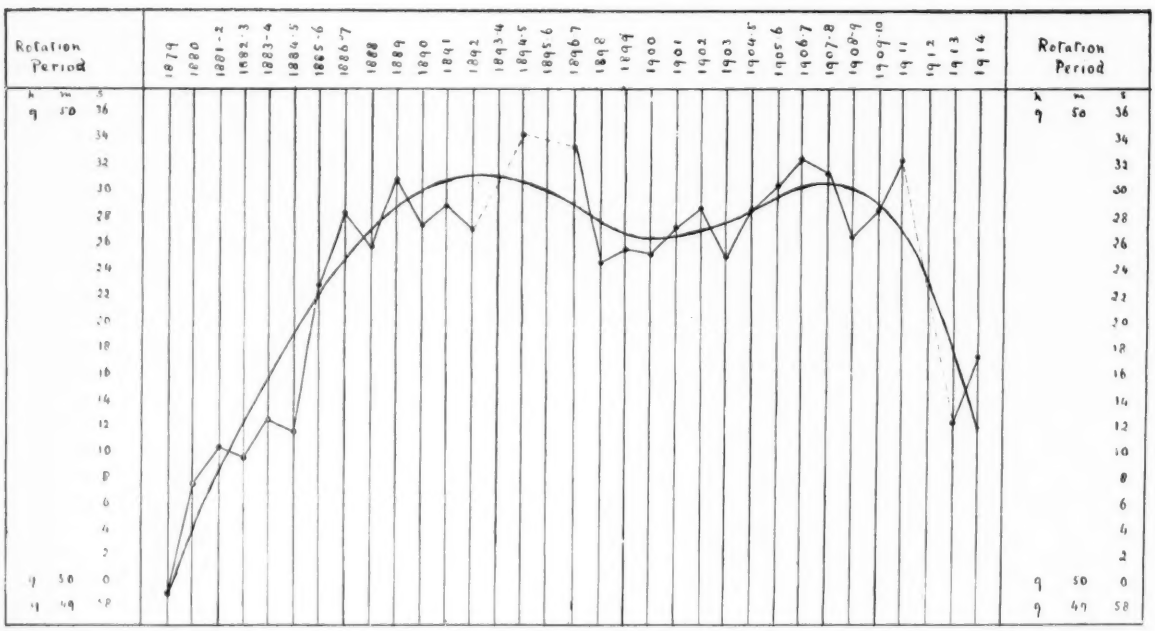

FIGURE 370.

Rotation Period of Equatorial Current, 1879 to 1914.

The value for 1914 is based on observations from May to August only.

velocity of different parts of the disc. Separate and distinct currents in the surface material of the planet whose latitudinal limits show only small changes have for several years been recognised, but their rates of motion are found to be variable. The drift of spots differs slightly from year to year, and there is reason to suppose that in some instances the variations in velocity are of a periodic nature, with minor fluctuations superposed on longer waves of considerable amplitude. Something of this kind seems probable in the cases of the Red Spot* and the great equatorial current. The motion of the former has been thoroughly discussed by Denning and by Kritzinger independently, and a period of, roughly, fifty years has been suggested. Figure 369 shows the changes in the position of the Red Spot during the last twenty years. It will be seen that since 1901 the longitude has diminished by well over two hundred degrees. The rotation period attained a maximum value of 9h 55m 42s± in 1899, but in the year 1913–14 (from opposition to opposition) this had become reduced to 9h 55m 35s±.

Figure 370 shows the changes in the rotation period of the great equatorial current since 1879. The diagram is based on weighted values derived from the results of various observers (cf. papers by A. S. Williams, *M.N.*, Volume LXIII, page 14, Volume LX, page 465, Volume LXXI, page 145; W. F. Denning, *M.N.*, Volume LXIII, page 331; Major P. B. Molesworth, *M.N.*, Volume LXV, page 691, and so on), B.A.A. Jupiter Section Memoirs, and so on; and shows that the rotation period in 1913 was practically the same as it had been thirty years earlier. The curve exhibits a slight secondary minimum about 1900, which gives it some resemblance to the light-curves of variable stars of the β Lyrae type; but observations extending over a much longer period are needed to show whether or not the changes are definitely periodic.

Some reference to the present appearance of the planet may be of interest. A comparison of the drawings of 1913 (see Figures 363, 364, and 365) with those of the current apparition shows that considerable changes have been in progress, and illustrates those characteristics of the surface markings which render Jupiter so attractive an object for telescopic scrutiny. It will be seen from Figure 367 that the South Tropical Disturbance is now clear of the Red Spot hollow, having just completed its sixth conjunction with that object, and that the Red Spot itself has once more emerged as a well-defined ellipse. To the writer, however, it shows no trace of red, but is neutral grey, presenting a striking contrast to the warm tone of the south equatorial belt. The longitude (ω_2) of the Red Spot at the end of August was about 202°. The South Tropical Disturbance now extends over 110° ± in longitude; the positions (ω_2) determined at Ashtead at the close of August being: Preceding end, 62° ±; following end, 173° ±.

It will be seen that marked changes have occurred in the north equatorial, north tropical, and north temperate regions of the planet. The brilliant egg-shaped markings which in 1913 formed a belt round the north part of the equatorial zone have become degraded into smaller and less regular white areas, whilst the dark protuberances are also very unequal in size, shape, and distance apart. Observations of thirteen north equatorial markings down to the end of August give a mean rotation-period of 9h 50m 17s·4, which is a slight increase on the value of last year.

Amongst recent developments must be mentioned the formation of dark spots on the north component of the north equatorial belt with white intermediate areas (some of them very bright) on the region between the two components of the belt. Still more interesting is the form assumed by some of the dark markings. They are distinctly arched to the south, and enclose small brilliant white spots, the appearance being suggestive of bridges, or sometimes links of a chain. At least seven objects are of this character, and an idea of their strange form may be gained from Figures 366 and 367. Observations of seventeen objects in this region show the rotation-period down to the end of August to have been 9h 55m 30s·6.

Another striking difference between the appearance of the planet in 1913 and 1914 is furnished by the south equatorial belt. Almost uniformly dark in the former year, it has recently consisted of two widely separated bands with a pale orange region between them.

* Some of the irregularities in the motion of the Red Spot have been associated with its conjunctions with the South Tropical Disturbance. During conjunction the motion becomes accelerated.

FLORA SELBORNIENSIS.

NOVEMBER, 11TH MONTH (*continued*).

19. The Bat mentioned is probably *Vesperugo pipistrellus;* the Dor-beetle is *Geotrupis stercorarius.* Of the fishes, the Bull's Head is *Cottus gobio;* the Eel, *Anguilla anguilla;* the Trout, *Salmo fario;* and the Stickleback, *Gasterosteus aculeatus.*

DECEMBER, 12TH MONTH.

8. The Flesh-fly is now *Sarcophaga carnaria* and the Song Thrush, *Turdus musicus.*

ERRATUM, October 17th.—Barometer reading, 30·0 inches should be 30·40 inches.

61.

Novem^{r} 14. The wood-lark, Alauda sylves: & the skie-lark, Alauda vulg: sing.
Flies appear still in numbers.
The Ground is now thoro'ly soaked.
16. The ripe berries of the yew tree, fall.
17:18. Tempestuous winds.
19. The bat, vespertilio, appears.
The common dor, or clock, scarabæus magnus niger vulgatissimus, is seen flying.

Fishes in the Rivulets at Selborne are the Bull's head, or Miller's thumb; Gobius fluviatilis capitatus; the trout, Trutta fluviatilis; the eel Anguilla, the ~~[illegible]~~ lamprey, lampetra ~~[illegible]~~ parva & fluviatilis; ~~[illegible]~~ piscicentus aculeatus, x
Decem^{r} 8. Delicate weather: the air is full of gnats, & the ground covered with spider's-webs: the flesh fly, musca carnaria, appears in numbers.
The song-thrush, turdus simpliciter dictus, sings.

x stickleback.

SOME INTERESTING FEATURES OF PHOTO-CHEMISTRY.

By H. H. McHENRY.

THE subject of Photo-chemistry is one about which comparatively little is known. While the applications to ordinary photography are well understood, the theory that leads to the chemical action of light is far from being perfectly comprehended.

The photo-chemical process has two phases. The production of a compound is one phase, such as the production of chlorine knall-gas. The other is decomposition, such as the decomposition of hydrogen phosphide with separation of phosphorus. This latter phase is by far the more common. The chemical action of sunlight, such as that shown in the bleaching process, the production of green colours in plants, and the well-known action of light used for blue-printing, have been known for centuries. Only recent investigations, however, have taught us that numerous compounds are sensitive to light, and convinced us that here we are dealing with a mutual action between ether vibrations and chemical forces. By experiment it is found that the chemical action of light takes place only in special cases, as it is held that illumination can exert an influence on the reäction velocity of a system which is in the process of change, or on a system in the state of equilibrium which is in chemical repose.

Before discussing the theory of the ether vibrations, it might be well to cite a few features of ordinary photography. The modern chemical method employed in development rests on what is known as the "latent light-action of the silver salts." A gelatine film impregnated with silver bromide is first illuminated and then treated with reducing agents. The silver haloid in the plate is then reduced to silver most quickly. At the illuminated spots this reduction results in the formation of free halogen, but the nature of the reduction product is not known in all cases. On the illuminated spots of the plate small particles of metallic silver are deposited by reduction, their density increasing with the intensity of light, but always in such small quantities that no visible change occurs in the substance of the plate. When the plate is put into the developer, those invisible silver particles act as nuclei for the precipitation of silver, just as small crystals bring about crystallisation in a super-saturated solution. The denser the silver particles at any spot, the denser will be the deposit of silver during development.

A valuable aid to photography was furnished in a discovery made by Vogel in 1878. He found that photographic plates may be made more sensitive by intermixture with slight traces of organic colouring substances. Also the plates are usually especially sensitive for kinds of light absorbed by particular colouring substances. Thus plates may be prepared sensitive to yellow, blue, or red, or any coloured light. This phenomenon is called optical sensitation. So far no theoretical explanation has been given for it.

As light is thought to be a phenomenon occasioned by ether vibrations, the theoretical consideration of its chemical effects must lie with these vibrations. When ether vibrations traverse a material system, they occasion two different results. Firstly, they raise the temperature of the system, their energy being partly converted into heat. Secondly, they occasion chemical changes, occurring at the expense of some of the energy of vibration. The first phenomenon is known as the absorption of light, the second as the photo-chemical absorption of light. Gases, liquids, and solids all respond to ether vibrations, such as the explosive mixture of hydrogen and chlorine, chlorine water, which gives up oxygen under the influence of light, and white phosphorus, which changes to the red modification, in light, or cinnabar, which turns black. While photo-chemical action may be produced by any type of ray, it depends on the wave-length of the light used, like ordinary absorption.

A set of empirical laws of photo-chemical action, compiled by Eder, serves as an aid to understand the chemical action of light-rays. They are: (1) Light of every wave-length is capable of photo-chemical action. (2) Only those rays are effective which are absorbed by the system, so that the chemical action of light is closely associated with optical absorption, although the converse is not true. (3) According to the nature of the substance absorbing light, every kind of light may act in an oxidising or reducing way. The red light has an oxidising effect, and violet light a reducing effect on the metals. (4) Not only the absorption of light-rays by the illuminated substance itself plays an important part, but also the absorption of light by a foreign substance mixed with the principal substance, for the sensitiveness can be stimulated for these rays which are absorbed by the admixed substance. (5) A substance sensitive to light, admixed with the main substance, and which unites with one of the products resulting from photo-chemical action (as oxygen, bromine, or iodine), tends to accelerate the reäction velocity to such an extent that reversal is impossible. This may be regarded as a consequence from the law of mass action.

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As stated above, these laws can only be regarded as empirical. There are some exceptions, notably, to (3). Red light exerts a reducing effect in the case of the latent light-action of the silver salts, while violet oxidises organic compounds, especially colourless ones. These laws were ascertained by means of instruments known as actinometers, which measure the intensity of the chemically active rays. The idea of actinometers is a most important one. All pieces of apparatus which are designed to measure this intensity, and which collectively depend upon the observed changes which are experienced by substances sensitive to light when under the influence of ether vibrations, are called actinometers. The data obtained from actinometers of all kinds must be considered as having a purely individual nature. They give only a *relative* measurement of the intensity, for if the same kind of light is used, the nature and reäction velocity of the chemical process occasioned in each case will vary according to the behaviour of the system which is subjected to the action of light. Also, when the light used consists of rays of different wave-length, the data of the same actinometer will by no means be proportional to the intensity of light, as the action of light varies greatly according to its wave-length.

It might be well here to consider a few types of actinometers. The eye can be considered an actinometer, because, apparently, its sensitiveness to ether vibrations depends upon certain photochemical processes which are thereby occasioned. However, the results of visual photometric measurement are not parallel with those obtained by actinometers, and neither results are parallel to those obtained by thermometric measurements. The latter is usually regarded as an absolute measure of radiation. It would perhaps be more correct to regard the diminution of free energy, which is unknown, associated with the change of radiant energy into heat, as the measure of the intensity of light.

A simple form of actinometer is that known as the chlorine knall-gas actinometer. It depends on a discovery of Gay-Lussac and Thénard in 1809, who found that, when strong light acted on the combining of chlorine and hydrogen, the velocity increased rapidly to the point of explosion, and, when weak light acted, it progressed slowly and steadily. The method consists in measuring the diminution of a volume of chlorine knall-gas (standing over water, and maintained at constant pressure and volume) as a result of the formation of hydrochloric acid, which is absorbed by the water. This actinometer was constructed by Draper in 1843, and, later, improved by Bunsen and Roscoe.

These two men discovered the silver-chloride actinometer, in which the time required to darken a photographic paper until a definite "normal" shade is reached is taken as a measure of light-intensity.

Another interesting actinometer is the electro-chemical actinometer. Two silver electrodes, which have been chlorinised or iodised, are dipped into a dilute solution of sulphuric acid. Electromotive force will be established between the electrodes, and as long as one of them is illuminated the current will flow in the solution from the unlighted to the lighted pole. The strength of the current is read by means of a sensitive galvanometer, and this serves to determine the intensity of the light. Results obtained by this actinometer agree approximately with those obtained in photometric ways. This actinometer was constructed by Becquerel in 1839.

Attention may now be turned to the work performed by chemically active light. One would expect the light to be absorbed to a greater degree when it occasions, or accelerates, a chemical process than when such is not the case. Bunsen and Roscoe found that when light passed through a layer of chlorine knall-gas it was much more weakened in its chemical activity than when it passed through chlorine alone. In both cases the light is weakened by absorption by the chlorine: the absorption by the hydrogen can be neglected. But in the first instance, absorption is purely due to optical activity, and, therefore, the loss of energy reäppears in the heat developed. In the second case, however, an additional fraction of light-energy is consumed in performing chemical work, which thus occasions a stronger absorption. This phenomenon is called photo-chemical extinction.

A word may be said as to the speed of chemical light-action. Bunsen and Roscoe found that light usually acts very slowly at first, and only attains its full activity after a lapse of time. This is called photo-chemical induction. Pringsheim succeeded in showing that this phenomenon is due to the formation of intermediate compounds. As chlorine knall-gas is more sensitive to light when moist than when dry, it seems probable that hydrogen and chlorine do not unite directly to form the acid, but that a series of intermediate compounds is first formed. Also a slight preliminary exposure of a photographic plate renders it more sensitive, and an under-exposed plate is strengthened by a subsequent exposure.

The physical laws which chemically active photographic rays obey are of peculiar interest. They are reflected, refracted, and polarised like other rays, their intensity diminishing as the reciprocal of the square of the distance from the point of origin. Research work has shown that when light of the same kind is used, the photo-chemical action depends solely on the product of the intensity and the duration of exposure. It has also been proved beyond doubt that the time required for the development of a normal colour on sensitive paper is proportional to the number of light-waves which strike the paper per second.

One important difference between photo-chemical reäctions and ordinary reäctions is that the velocity in the former increases but little in a rise of

temperature, while that of the latter increases enormously. We are led to believe that light-action should not be regarded as a direct loosening of the atoms in a molecule such as that effected by heating, but rather the primary effect must be some action on the luminiferous ether, and suggests ionisation.

Now what is the cause of these light-vibrations? The latest authorities maintain that light-vibrations are produced by electric agitations, and that in the chemical action of light we deal with phenomena not far removed from the formation and decomposition of compounds under the influence of the galvanic current. That chemical equilibrium is affected by illumination follows from the change in the thermodynamic potential of components by illumination, as may be more clearly deduced from the electro-magnetic theory of light. It has been proved that electrification and magnetism alter the thermodynamic potential, and the action of light-waves is, according to the most advanced theories, that of rapidly alternating electric fields. From these conclusions we may assume, at least until further knowledge of the subject is gained, that the ultimate cause of the photo-chemical action of light lies in electric phenomena.

SOLAR DISTURBANCES DURING SEPTEMBER, 1914.

By FRANK C. DENNETT.

THE SUN was observed every day during September. On one day only (7th) did the disc appear free from disturbance, but on the six previous days only faculae were visible. Spots were visible on and after the 8th until the month ended. The longitude of the central meridian at noon on September 1st was 259° 53′.

No. 28.—A spot, some eighteen thousand miles in diameter, had come round the south-eastern limb on the 8th, its umbra being comparatively small. From the 10th until the 17th much change took place in the form of the umbra. There was a pore a little north of east on the 13th, and two south-east on the 15th. It was shrinking on the 18th, and was last seen near the south-western limb on the 20th. On the 12th, 15th, 17th, and 19th the penumbra seemed to brighten inwardly.

No. 29.—This appears to be a return of No. 24, very little decreased in size, first seen on September 9th. On the 10th the inner edge of the penumbra was noted as brighter. Little bright tongues penetrated the northern edge of the umbra on the 13th and 16th. On the 17th the southern part of the umbra was darkest. After the 18th the umbra was cut into two by a bright bridge, and on the 20th the penumbra increased to northward. It was last seen on the 22nd. Both near the following and preceding limb, it was seen to be accompanied by a great amount of faculae, extending so far as 31° N. A tiny pore was close to its northern edge on the 13th and 16th, two others near its south-eastern border on the 16th, and next day one to the east and another south-east.

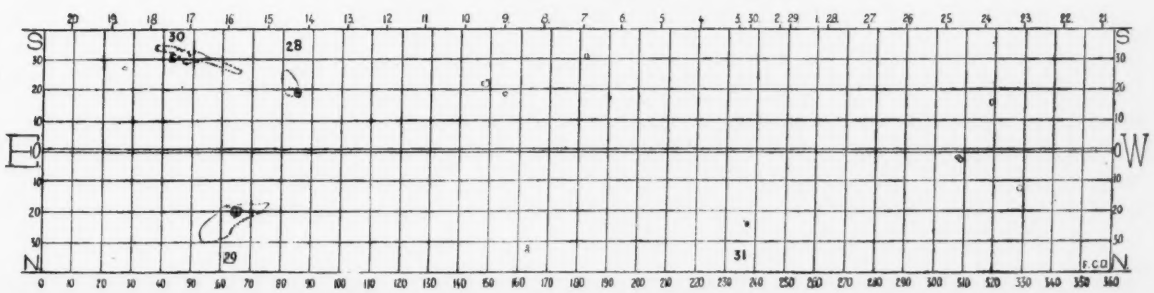
No. 30.—What appeared as a large spot appeared close to the south-eastern limb on September 11th, preceded by faculae, was seen next day to be two spots. On the 13th there was a pore some 8° ahead; this had gone next day, when there was a comma-shaped spot with a pore away to the east. On the 15th the comma formed the eastern extremity of an ellipse, outlined with pores, having a major axis some 6° in length. The tail broke off on the 16th, and was widely separated on the 17th, when last seen, the region being marked by faculae as it drew near the south-western limb from the 20th until the 23rd. Its greatest diameter was fifteen thousand miles.

No. 31.—On the 23rd a spot nine thousand miles in diameter came into view close to the north-eastern limb. A pore was seen close to it next day, but not observed after. On the 25th the inner border of the penumbra was brightly fringed, and next day the umbra was divided by a bridge. On the 29th and 30th the umbra was broken into four parts, and on October 1st the penumbra seemed gone. Nothing more was seen of the spot after.

Faculae were recorded near the western limb (308°, 2° N.) on September 30th; near the north-western, September 1st to 3rd; near the north-eastern, September 3rd and 30th (163°, 31° N.); on the south-western, September 1st (319°, 16° S.), 14th, and 19th till 23rd, the remains of No. 30; and near the south-eastern on 1st (182°, 30° S.), 2nd, 3rd, 4th (155°, 19°, and 149°, 22° S.), 5th, 6th, 11th, and 14th (27°, 27° S.). Little faculic knots were observed near the North Pole on September 22nd, 23rd, 25th, 26th, and 30th.

Our chart is constructed from the combined observations of Messrs. J. McHarg, E. E. Peacock, J. C. Simpson, and F. C. Dennett.

DAY OF SEPTEMBER, 1914.



THE FACE OF THE SKY FOR DECEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 50.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Vesta. R.A.	Vesta. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Dec. 4	16 39·9	S.22·2	6 3·9	N.27·7	15 30·3	S.17·5	15 54·3	S.20·4	5 2·1	N.17·1	21 20·1	S.16·5	6 0·9	N.22·3	8 9·2	N.19·7
,, 9	17 1·7	22·8	10 24·4	N. 9·5	16 0·1	19·7	15 46·2	18·7	4 56·6	17·2	21 23·3	16·3	5 59·2	22·3	8 8·8	19·8
,, 14	17 23·7	23·2	14 44·8	S. 21·1	16 31·5	21·7	15 42·0	17·4	4 51·1	17·3	21 26·8	16·0	5 57·5	22·3	8 8·4	19·8
,, 19	17 45·9	23·4	20 6·6	S. 22·8	17 4·1	23·2	15 41·8	16·6	4 45·8	17·4	21 30·4	15·7	5 55·7	22·3	8 8·0	19·8
,, 24	18 8·1	23·4	0 8·2	N. 4·1	17 37·8	24·2	15 45·4	16·1	4 40·9	17·5	21 34·2	15·4	5 53·9	22·3	8 7·5	19·8
,, 29	18 30·3	S.23·3	3 59·7	N.25·8	18 12·2	S.24·8	15 52·3	S.16·0	4 36·5	N.17·6	21 38·1	S.15·1	5 52·2	N.22·3	8 7·0	N.19·9

TABLE 51.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Dec. 4	+ 15·1	+0·4	99·9	− 0·4	−19·8	+0·2	115·2	306·3	6 42 *e*	11 25 *e*
,, 9	13·0	−0·3	34·0	+19·8	20·0	0·2	183·5	336·5	4 50 *e*	10 35 *e*
,, 14	10·8	0·9	328·2	+17·1	20·2	0·3	251·8	6·6	2 58 *e*	9 46 *e*
,, 19	8·5	1·5	262·3	−10·8	20·5	0·3	320·0	36·7	10 57 *e*	8 56 *e*
,, 24	6·1	2·1	196·4	−22·2	20·7	0·3	28·3	66·8	9 5 *e*	8 6 *e*
,, 29	+ 3·7	−2·8	130·6	−11·6	−21·0	+0·3	96·5	96·9	7 13 *e*	7 16 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}7$, $9^h\ 55^m{\cdot}8$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN passes the Winter Solstice $22^d\ 4^h\ e$. Its semi-diameter increases from 16′ 15″ to 16′ 18″. Sunrise changes from $7^h\ 44^m$ to $8^h\ 8^m$; sunset from $3^h\ 53^m$ to $3^h\ 58^m$.

MERCURY is a morning star. Semi-diameter diminishes from 3″ to 2½″. Illumination increases from $\frac{8}{10}$ to Full. 21′ North of Venus $7^d\ 3^h\ e$.

VENUS is a morning star, stationary on 17th. Illumination increases from zero to ¼. Semi-diameter diminishes from 32″ to 21″.

THE MOON.—Full $2^d\ 6^h\ 21^m\ e$. Last quarter $10^d\ 11^h\ 32^m\ m$. New $17^d\ 2^h\ 35^m\ m$. First quarter $24^d\ 8^h\ 25^m\ m$. Perigee $15^d\ 2^h\ e$. Apogee $27^d\ 1^h\ e$, semi-diameter 16′ 36″, 14′ 46″ respectively. Maximum librations $1^d\ 7°$ S., $9^d\ 6°$ E., $15^d\ 7°$ N., $21^d\ 7°$ W., $29^d\ 7°$ S. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 52).

MARS is invisible; in conjunction with Sun on 24th.

JUPITER is an evening star, in Capricornus, 28′ North of ε Capricorni November 30th. Polar semi-diameter 17″; near Moon on 21st.

Configuration of satellites at $5^h\ 30^m\ e$ for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Dec. 1	2	○	134		Dec. 17		○	1234	
,, 2	21	○	34		,, 18	1	○	324	
,, 3		○	1234		,, 19	32	○	14	
,, 4	1	⊙	24		,, 20	312	○	4	
,, 5	32	○	14		,, 21	3	○	124	
,, 6	341	○		2●	,, 22	1	⊙	34	
,, 7	43	⊙	2		,, 23	24	⊙	3	
,, 8	42	○	3	1●	,, 24	4	○	213	
,, 9	421	○	3		,, 25	41	○	32	
,, 10	4	○	123		,, 26	4⅔	○	1	
,, 11	41	○	32		,, 27	4312	○		
,, 12	4⅔	○	1		,, 28	43	○	12	
,, 13	3412	○			,, 29	413	○	2	
,, 14	3	○	12	4●	,, 30	24	○	13	
,, 15	2	○	34	1●	,, 31		○	43	1●2●
,, 16	21	○	34						

The following satellite phenomena are visible at

Greenwich, all in the evening:—4d 6h 12m 13s III. Tr. E., 7h 29m 20s III. Sh. I.; 6d 4h 15m 54s II. Oc. D., 5h 40m 24s IV. Sh. I., 7h 50m 5s I. Oc. D.; 7d 5h 2m 6s I. Tr. I., 6h 12m 56s I. Sh. I., 7h 20m 2s I. Tr. E., 8h 30m 39s I. Sh. E.; 8d 4h 20m 54s II. Sh. E., 5h 46m 56s I. Ec. R.; 11d 6h 52m 0s III. Tr. I.; 13d 7h 2m 53s II. Oc. D.; 14d 7h 2m 2s I. Tr. I., 8h 3m 5s IV. Oc. R., 8h 8m 47s I. Sh. I.; 15d 4h 7m 53s II. Sh. I.; 4h 19m 22s I. Oc. D., 4h 46m 52s II. Tr. E., 5h 15m 44s III. Ec. R., 6h 56m 37s II. Sh. E., 7h 42m 5s I. Ec. R., 3h 50m 14s I. Tr. E., 4h 55m 34s I. Sh. E.; 22d 4h 42m 52s II. Tr. I., 5h 9m 27s III. Oc. R., 5h 40m 32s III. Ec. D., 6h 19m 25s I. Oc. D., 6h 43m 33s II. Sh. I., 7h 32m 12s II. Tr. E.; 23d 4h 33m 31s I. Sh. I., 4h 41m 34s IV. Sh. E., 5h 51m 3s I. Tr. E., 6h 51m 29s I. Sh. E.; 24d 4h 5m 54s I. Ec. R., 4h 15m 22s II. Ec. R.; 29d 5h 54m 41s III. Oc. D., 7h 29m 10s II. Tr. I.; 30d 5h 34m 2s I. Tr. I., 6h 29m 15s I. Sh. I.; 31d 4h 12m 3s IV. Oc. R., 6h 0m 54s I. Ec. R., 6h 53m 52s II. Ec. R.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is in opposition on 21st, in Gemini. Polar semi-diameter 9½″. Major axis of ring 48″, minor 21½″. Angle P−6°·0.

Eastern elongations of Tethys (every 4th given) 8d 9h·7 *m*, 15d 10h·9 *e*, 23d Noon, 31d 1h·2 *m*; of Dione (every 3rd given) 2d 3h·8 *e*, 10d 8h·7 *e*, 19d 1h·7 *m*, 27d 6h·7 *m*; of Rhea (every 2nd given) 7d 3h·8 *m*, 16d 4h ·4 *m*, 25d 5h·1 *m*.

For Titan and Japetus E., W. stand for East and West elongations, I. for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan 2d 11h·0 *e* E., 6d 9h·8 *e* I., 10d 6h·3 *e* W., 14d 6h·3 *e* S., 18d 8h·6 *e* E., 22d 7h·2 *e* I., 26d 3h·9 *e* W., 30d 3h·8 *e* S.; Japetus 12d 5h·5 *e* W., 31d 2h·9 *e* S.

URANUS is an evening star in Capricornus, 1° North of Moon on 20th, R.A. 20h 47m S. Dec. 18°·6.

NEPTUNE is a morning star, coming into a better position for observation. 2¼° S. of Moon on 6th.

COMETS.—See "Notes on Astronomy" in this number.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
Nov. 25-Dec. 12	189	+ 73	Rather swift.
Dec. 4 ...	162	+ 58	Swift, streaks.
,, 6 ...	80	+ 23	Slow, bright.
,, 8 ..	145	+ 7	Swift, streaks.
,, 8 ..	208	+ 71	Rather swift.
,, 10-12 ...	108	+ 33	Swift, short.
,, 12 ...	119	+ 29	Rather swift.
,, 20-25 ...	168	+ 33	Swift, streaks.
,, 22 ...	194	+ 67	Swift, streaks.
,, 21-22 ...	117	+ 47	Swift.
,, 31 ...	92	+ 57	Slow, bright.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 53).

TABLE 52. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
Dec. 1 ...	17 Tauri	3·8	6 6 *e*	104	6 59 *e*	211
,, 1 ...	16 Tauri	5·4	6 7 *e*	63	7 12 *e*	253
,, 1 ...	19 Tauri	4·3	6 33 *e*	29	7 26 *e*	286
,, 1 ...	20 Tauri	4·1	6 38 *e*	66	7 47 *e*	250
,, 1 ...	22 Tauri	6·5	6 58 *e*	34	7 56 *e*	281
,, 1 ...	21 Tauri	5·8	7 0 *e*	23	7 49 *e*	292
,, 1 ...	BD + 24°·562	7·0	7 21 *e*	55	—	—
,, 1 ...	BD + 23°·540	7·0	7 37 *e*	61	—	—
,, 1 ...	Wash. 227	6·6	8 25 *e*	147	—	—
,, 4 ...	BD + 27°·880	7·0	—	—	4 49 *m*	310
,, 4 ..	BD + 27°·1122	7·0	—	—	7 49 *e*	316
,, 5 ...	A Geminorum	5·1	7 8 *e*	43	7 43 *e*	325
,, 6 ...	BAC 2506..	6·3	2 38 *m*	89	3 51 *m*	312
,, 6 ...	BAC 2514	6·0	3 16 *m*	101	4 31 *m*	301
,, 7 ...	η Cancri	5·5	3 41 *m*	138	4 53 *m*	277
,, 8 ...	Wash. 672	7·0	—	—	11 2 *e*	305
,, 18 ...	Wash. 1283	7·4	4 29 *e*	52	—	—
,, 20 ...	31 Capricorni	6·3	5 28 *e*	31	6 27 *e*	266
,, 21 ...	e^2 Aquarii	5·4	7 4 *e*	19	7 55 *e*	274
,, 25 ...	51 Piscium	5·6	0 19 *m*	5	—	—
,, 29 ...	16 Tauri	5·4	3 35 *m*	140	4 7 *m*	209
,, 29 ...	19 Tauri	4·3	3 36 *m*	93	4 31 *m*	256
,, 29 ...	21 Tauri	5·8	3 56 *m*	76	4 49 *m*	273
,, 29 ...	20 Tauri	4·1	3 57 *m*	121	4 40 *m*	228
,, 29 ...	22 Tauri	6·5	3 59 *m*	83	4 53 *m*	266
,, 29 ...	BD + 24°·562	7·0	4 21 *m*	89	—	—
,, 31 ..	Wash. 435	6·7	9 36 *e*	83	—	—

Attention is called to the two occultations of the Pleiades, in the East on December 1st, in the West on December 29th.

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

XUM

TABLE 53. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
R Tauri	4 24	+10 ·0	7·4 to 13·8	325	Oct. 31.
T Leporis	5 1	−22 ·0	7·5 to 12·3	366·5	Dec. 7.
S Camelop.	5 32	+68 ·8	7·8 to 10·8	330	Nov. 15.

Minima of Algol $2^d\ 9^h\cdot9\ e$, $5^d\ 6^h\cdot7\ e$, $8^d\ 3^h\cdot5\ e$, $17^d\ 6^h\cdot0\ m$, $20^d\ 2^h\cdot8\ m$, $22^d\ 11^h\cdot6\ e$, $25^d\ 8^h\cdot4\ e$, $28^d\ 5^h\cdot3\ e$.
Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae December $1^d\ 8^h\ m$, $14^d\ 6^h\ m$, $27^d\ 4^h\ m$. Period $12^d\ 21^h\ 47^m\cdot5$.

THE SELBORNE MAGAZINE.

FROM time to time *The Selborne Magazine* reflects the archaeological interests which occupied, with natural history, the attention of Gilbert White.

In a recent number there was a striking article, by Mr. W. Ruskin Butterfield, on "Sussex Draught Oxen," which are now reduced, we believe, to a single team. Their harness and shoes are therefore practically a thing of the past, and we are pleased to reproduce, by permission, some of the interesting photographs (see Figures 371 to 374) which Mr. Butterfield took to illustrate his remarks.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE TOTAL SOLAR ECLIPSE.—The observers have now returned, and it is possible to form an idea of the results obtained. The successful parties were those at Hernosand, Riga, Minsk, and a few in the Crimea. The British party in this last region was singularly unfortunate, being disappointed by a small cloud over the Sun in an otherwise clear sky.

I have seen some of the photographs taken at Minsk. The prominences were very numerous and active, several having fantastic forms, suggesting a caterpillar, a galloping horse, and a clump of Jersey cabbages. The corona has been classified as of intermediate type; I should call it slightly modified minimum type. The polar plumes are still very pronounced; the equatorial streamers are wider than at dead minimum, but the large streamers at considerable inclination to the equator that were so prominent in 1898 are absent. It is curious that the coronal type of waxing activity is much less known than those of the other phases, so it is to be hoped that the eclipse of February, 1916, will be successfully observed.

MARS.—Professor W. H. Pickering gives, in *Popular Astronomy* for August, a final discussion of his observations of the recent apparition. He insists on the objective reality of the canals, and also on the fact that the aperture of the telescope used for their study cannot be advantageously extended beyond a certain point, depending on the steadiness of the air at the observing station. He gives a sketch of the Full Moon made with an opera-glass, showing many canaliform markings, and suggests that a study of these under higher optical power throws light on the Martian problem. He gives some diagrams of what the Martian canals might look like if we could see them under much higher optical power: these comprise single strips, double strips, and sets of dots very close together, forming a belt either straight or slightly sinuous; limits are given to the extent to which the real marking may diverge from straightness and uniformity without affecting the optical image that we see. He notes that "all the larger and more conspicuous canals are curved; the fainter ones, on the other hand, usually appear straight," thus suggesting that the straightness is an illusion. He suggests belts of vegetation, as the most plausible explanation of the canals; and, without laying stress on it, adds the conjecture that, if they are artificially controlled, the means employed might be the local deposition of moisture from the atmosphere by electrical or other means. He says these conjectures "account for the observed facts more readily than any others, and any theory, even a false one, is better than none at all."

ENCKE'S COMET.—This best known of all the short-period comets has been observed at Simeis, Crimea, this being its thirty-third observed apparition. Perihelion will be Dec. 4·9867, Berlin M.T., about half an hour earlier than that predicted by Herr L. Matkewitsch. In "KNOWLEDGE" for October, 1911, I predicted the date 1914, Dec. 5·0, which is almost exactiy right. I can now extend the prediction to the following return, which comes out 1918, March 25·0. Winter returns are the most favourable for observation, and the comet is likely to be a conspicuous telescopic object in November.

Ephemeris for Berlin noon :—

Date.	R.A. h	m	s	Dec. °	′
Nov. 6	13	23	49	 21	58 N.
,, 10	13	45	48	 12	43 N.
,, 14	14	2	13	 5	20 N.

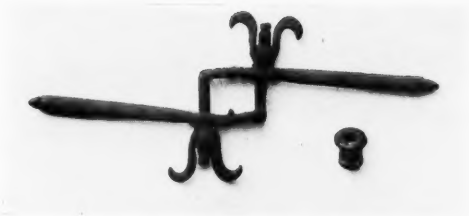


FIGURE 371.
Appliances used in securing the brass knobs on the horns of bullocks, and one of the knobs.
Found in a blacksmith's shop at Northiam.

FIGURE 372.
Ox-yoke in the Hastings Museum, from Bishopstone Manor Farm.

FIGURE 373.
Bullocks' Shoes, and Nails used in fastening them.

The upper pair was picked up on the side of Firle Beacon, the lower pair was found in a blacksmith's shop at Brede, and the nails are from Battle.

FIGURE 374. A Team of Sussex Oxen.

By the courtesy of *The Selborne Magazine*.

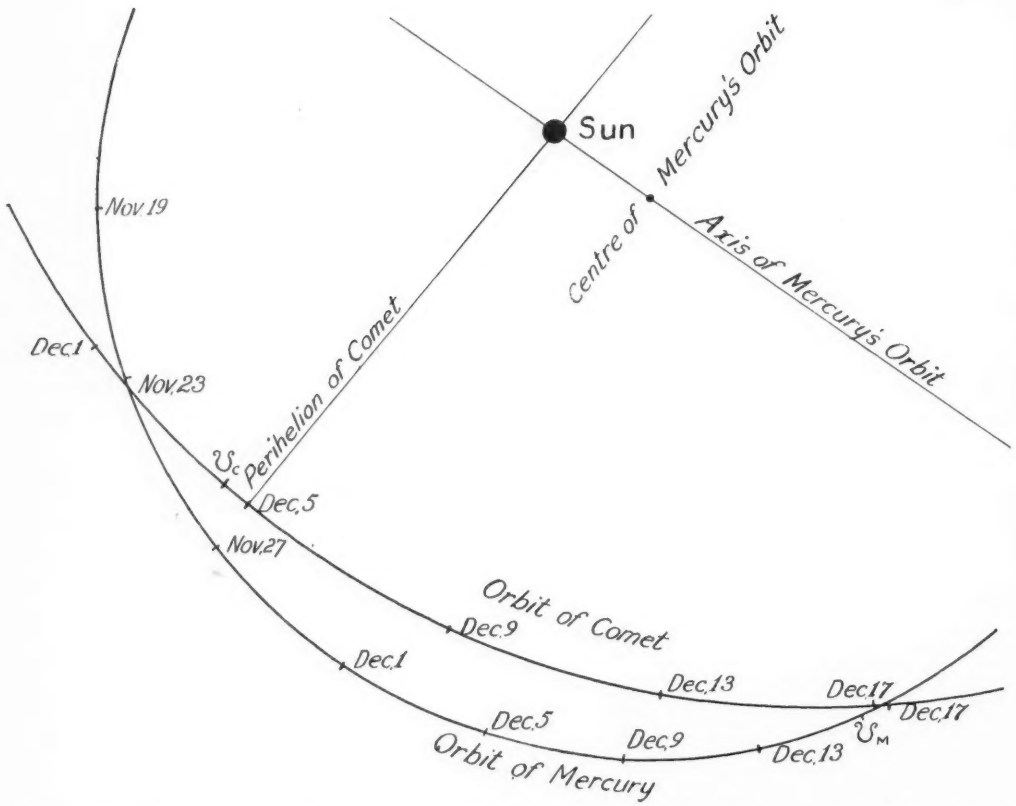


FIGURE 375. The perihelion portion of the Orbit of Encke's Comet, and the adjacent portion of Mercury's Orbit, illustrating the approach of the two bodies. 1914, December 16th.

The symbols ☋C, ☋M denote the descending nodes of Comet and Mercury on the plane of ecliptic. On December 16th Mercury is in plane of ecliptic, the Comet about nine million miles below it.

FIGURE 376. Delavan's Comet, September, 1914.
Roughly sketched from a photograph taken by F. W. Longbottom.

Date.	R.A. h	m	s		Dec. °	′	
Nov. 18	14	15	40	.....	0	45	S.
,, 22	14	28	20	.....	5	50	
,, 26	14	41	46	.....	10	16	
,, 30	14	57	33	.....	14	20	
Dec. 4	15	17	20	.....	18	3	
,, 8	15	41	12	.....	21	18	
,, 12	16	7	27	.....	23	54	
,, 16	16	34	6	.....	25	50	S.

The comet will be within ten million miles of Mercury on December 16th (see Figure 375). It can at times approach even closer. These approaches have been utilised for obtaining the mass of Mercury, which is so small that its effect in disturbing even its neighbour, Venus, can scarcely be detected. But Encke's Comet can approach much more closely, and Professors von Asten and Backlund have studied the disturbances that Mercury produces on it, and find that the mass of Mercury is about one twenty-seventh of that of our own Earth. The effect of a near approach is not noticeable at once, as some imagine. All that Mercury has done is to alter the speed and direction of motion of the comet to a very slight extent. It is not till several years have elapsed that there is a sensible displacement of the comet from its predicted position. In the same way the effect of our Earth on Halley's Comet is scarcely noticeable at the time that it is near us, but it may make as much as two or three weeks' difference in the time of its return to perihelion seventy-five years later.

In 1848 the perihelion of Encke's Comet was on November 26th, nine days earlier than in the present year. The conditions as to visibility from the Earth were thus almost identical, and it is interesting to put on record the observations made then in order to ascertain how much loss of brilliance the comet has suffered in sixty-six years. It was discovered by Bond at Cambridge, U.S.A., on August 27th, 1848, as compared with September 20th this year (when its magnitude was given as 14·0). During September, 1848, and up to October 7th, it was described by Dr. Schmidt, of Bonn, as very faint and ill-defined, diameter nearly 8′, no nucleus or condensation, much harder to observe than most comets. On the other hand, on November 9th, he described the light of the comet as unusually intense, of the purest white; the condensation near the centre was very pronounced. It bore a magnifying power of two hundred or three hundred. The coma was 3′ or 4′ in diameter, but there was not much trace of a tail. I hope that our readers will observe it in the present month to admit of comparison.

Another bright comet was discovered on September 18th by Dr. Lunt, of the Cape Observatory. Many members of the British Astronomical Association who went to Vadso for the eclipse of 1896 will remember him. It was at first invisible in Europe, but has moved northward. By the time this appears the comet will probably be a telescopic object, but it is worth while to give the elements found by Mr. Wood and a portion of the ephemeris (for Greenwich midnight) :—

T, August 4·99; ω, 270° 19′; Ω, 0° 22′; i, 77° 51′; log. q, 9·8543.

Date.	R.A. h	m	s		N. Dec. °	′
Nov. 6	21	47	21	.....	5	42
,, 10	21	48	28	.....	6	44
,, 14	21	50	4	.....	7	38
,, 18	21	51	57	.....	8	28

DELAVAN'S COMET.—There has been other activity in this field. Delavan's Comet, in its conspicuous position under the Plough, attracted general attention. An interesting photograph, taken by Mr. Longbottom (see Figure 376), showed that the tail consisted of a long, straight streamer, traceable for at least eight degrees, accompanied by a shorter, broader, slightly curved streamer, separated from it by a dark rift. It somewhat resembled the well-known pictures of Donati's Comet; but the straight streamer in Delavan's is relatively brighter, and the curvature of the broad streamer is less. The comet will still be observable as a morning star in November, but it will be very low down. The following is a rough ephemeris :—

Date.	R.A. h	m		Dec. °	′	
Nov. 5	14	47	.....	19	4	N.
,, 15	15	16	.....	13	24	
,, 25	15	39	.....	7	0	
Dec. 5	15	58	.....	1	0	N.
,, 15	16	14	.....	4	0	S.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

SYMBIOSIS BETWEEN FRESHWATER MOLLUSCS AND ALGAE.—Several cases of symbiosis, or mutual partnership, between algae and animals (protozoa, sponges, and so on) have been already recorded. One of the most remarkable is that between certain marine red algae and sponges, discovered by Mme. van Bosse in her work on tropical algae; in some cases the alga branches profusely and ramifies through the canal system of the sponge, the alga using for food the carbon dioxide given off by the living sponge tissues, obtaining its salts from the water passing through the canals, and, on the other hand, supplying the sponge with the oxygen given off in photosynthesis. More recently Iltis (*Biol. Centralbl.*, Volume XXXIII, No. 12) has described a form of the common freshwater red alga, *Batrachospermum* (*B. vagans* var. *epiplanorbis*), which always grows on the shell of the freshwater mollusc, *Planorbis*. The mollusc gains by being protected from enemies, being densely clad with the alga, and is also able to live in places which would be otherwise unfit for it owing to poverty of oxygen and excess of carbon dioxide, the former gas being supplied, and the latter removed, by the alga. Further, the *Batrachospermum* lives in symbiosis with the blue-green alga *Nostoc*, colonies of which are lodged among its branches. The author describes some other similar cases of symbiosis between freshwater snails of the genus *Limnea* and a number of green algae belonging to the genera *Vaucheria*, *Cladophora*, *Chaetophora*, and *Oedogonium*. It would appear that this simple type of symbiosis is fairly common among pond organisms.

TRANSPIRATION AND OSMOTIC PRESSURE IN MANGROVE TREES.—The well-known mangrove vegetation of tropical shores, forming one of the most sharply defined of all plant communities, consists of trees showing marked "xerophilous" characters—thick, leathery leaves with sunken stomata, and so on—which have been usually attributed to "physiological drought." According to this view, flowering plants growing in saltwater live under practically the same conditions as plants growing in physically dry soil, since the salinity makes it difficult for them to obtain a sufficient supply of water, and from the structure of their leaves it has been generally assumed that they lose very little water by transpiration. However, various recent observers have found by experiment that many supposed "xerophytes" lose water from their leaves at a fairly rapid rate. Faber (*Ber. deutsch. bot. Ges.*, Volume XXXI) has found that this is the case with the mangrove trees, which are rooted in mud covered by seawater, and he also finds that the osmotic pressure in the cells of these plants is extremely high—very much higher than that observed in plants growing in ordinary soil. This high concentration of the sap is especially marked in the leaves, and experiments showed that the mangrove plants have a remarkable capacity for the regulation of their osmotic pressure in such a way that their sap always remains more concentrated than the water by which the roots are surrounded. It has already been proved that the fleshy desert and salt-marsh plants, previously regarded as typical "xerophytes," that is, plants which economise their water supply and lose very little in the form of water vapour from their leaves, are,

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when tested by actual experiment instead of by pure inference from structural features, found to show a relatively large rate of water loss (transpiration), often quite as large as that of " mesophytes " (thin-leaved plants growing where the water supply is ample and there are no obvious features for checking water loss). These observations show the danger of inferring too much about the physiology and ecology of plants from details of form and structure alone.

TRANSPIRATION IN CACTI.—Various recent observers have shown that many plants with fleshy leaves or stems, which were formerly regarded as typical " xerophytes," from general and superficial observation of their habitat and habit, or in some cases from the anatomical structure of their aërial organs, and which were supposed to lose water very slowly by virtue of their water-storing tissues and their " adaptations " for checking water loss, prove on actual experiment to lose water quite as rapidly as " mesophytic " plants devoid of such arrangements for water economy. In one of the latest papers on this subject Bedelian (*Bull. Jard. imp. bot.*, St. Petersburg [Petrograd], 1913) gives the results of transpiration experiments made with the cactus, *Opuntia tomentosa*, a number of other plants being also used for comparison. The amounts of water, in grammes, lost from equal areas of green surface (flat stem in *Opuntia*, leaves in the other plants) in an hour were as follows: Ivy, 0·0082; oleander, 0·0057; *Tropaeolum*, 0·0066; sunflower, 0·1059; *Opuntia*, 0·0063. It is remarkable that a thin-leaved plant like *Tropaeolum* should transpire at practically the same rate as the cactus and the oleander: the last-named plant has its stomata protected by being grouped in cavities of the leaf, opening by a hole, which is guarded by hairs. Some of the unexpected results of this kind obtained by experiment may be explained by the very different behaviour of the stomata in different plants, as well as in the same plant under different conditions. However, it is, at any rate, obvious that " xerophyte " and " xerophilous " are at present very vague and much-abused terms, and that ecological conceptions and terms must be based on accurate experimental work in plant physiology; also that much remains to be done on the transpiration of plants and the various factors, internal and external, by which it is controlled.

PARASITISM IN THE YELLOW-RATTLE TRIBE.—The yellow-rattle tribe (Rhinantheae) of the family Scrophulariaceae has been closely investigated from the biological point of view by Heinricher, who has published various papers on these interesting plants. As is well known, *Rhinanthus* (yellow-rattle) and its allies, *Pedicularis* (red-rattle, lousewort), *Melampyrum* (cow-wheat), *Bartsia*, and so on, are partial parasites, drawing water and salts from various grasses and other plants, to whose roots theirs are attached by suckers, while they have green leaves, and can therefore carry on photosynthesis. However, it seems that, under the general description " semi-parasitism," there is comprised in this tribe a number of distinct, but closely connected, stages between slight parasitism and almost complete dependence upon the host plant for both organic and inorganic food materials. In a recent paper Heinricher (*Ber. nat.-med. Ver. Innsbruck*, Volume XXXIV) summarises his observations on this tribe, and describes the interesting series of forms which at one end join on to the normal Scrophulariaceae, obtaining their food materials in the usual way from the salts in the soil and the carbon dioxide of the air, and at the other end lead to the totally parasitic Orobanchaceae, including toothwort (*Lathraea*) and broomrape (*Orobanche*), and regarded as having arisen by reduction from the Scrophulariaceae. The series begins with the eyebrights (*Euphrasia*), which apparently take only water and salts from the host plant, and in which normal carbon assimilation is performed by the leaves. These, and other true green parasites, show an extremely rapid rate of transpiration, correlated with their method of taking up nutritive salts at second hand. In the rattles (*Rhinanthus*, *Pedicularis*) a certain amount of organic food is absorbed by the roots, and the leaves show a reduction of the assimilating tissues: this is still more pronounced in cow-wheat (*Melampyrum*) and *Bartsia*. In *Tozzia alpina* there is a more marked approach to absolute parasitism, the plant living for a year or two years as a semi-parasite, and for several years as an absolute parasite. These various stages are marked by corresponding differences in structural details of leaf, stem, root, seed, and so on.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

ACETIC ACID FROM ACETYLENE.—Two recent French patents of the German firm, Bayer & Co., claim methods of manufacturing acetic acid from acetylene. According to the first of these, a current of the acetylene is passed through a solution containing hydrogen peroxide, persulphuric acid, or one of its salts, in the presence of mercury, or one of its compounds. For example, the gas is made to traverse a mixture of dilute sulphuric acid and ammonium persulphate solution, in which is suspended 5 to 10 parts of mercuric oxide. The temperature is meanwhile maintained at 30° to 40° C., and the liquid will finally contain from twenty-four to twenty-five per cent. of acetic acid, which may be separated and concentrated by distillation.

In the other process an electrolytic cell with a clay diaphragm and a lead anode is charged with dilute sulphuric acid containing one to two per cent. of mercuric oxide, and the acetylene is passed through the liquid previously heated to about 30° C. A regulated electric current effects the oxidation of the acetylene, and about a pound of acetic acid per quart of the solution is obtained.

In view of the scarcity of acetic acid for pickling purposes, owing to the stoppage of the supplies from Belgium, Germany, and Sweden, these processes could probably be profitably worked in this country.

TWO NEW MODIFICATIONS OF PHOSPHORUS.—The element phosphorus is remarkable for the large number of allotropic modifications which it yields under different conditions of temperature. The red amorphous variety and the scarlet modification are the best known of these forms, and both of these are of commercial importance in the match industry. Several other modifications are known, and in the last issue of the *Journ. Amer. Chem. Soc.* (1914, XXXVI, 1344) Mr. P. Bridgman gives an account of two more. The first of these, which he terms " White Phosphorus II," is a hexagonal crystalline form obtained by cooling ordinary white phosphorus to about −76° C. at the ordinary atmospheric pressure. The other modification is a black variety, which is formed when white phosphorus is heated to about 200° C. under high pressure. It does not ignite spontaneously, and acts as a good conductor of heat and electricity, while it melts at a somewhat higher temperature than red phosphorus. Its density is 2·691, and its vapour pressure is lower than that of red phosphorus.

COAL TAR PITCH AND CANCER.—In a pamphlet published last year by Doctors Ross and Cropper, and reviewed at the time in " KNOWLEDGE," a scientific explanation was suggested of the facts that workmen handling gasworks tar are subject to epitheliomatous cancer, whereas those engaged in the distillation of the pitch from blast furnaces are not affected in this way.

Starting from the hypothesis that two of the factors inducing cancer are (1) rapidly proliferating cells on a chronically injured surface and (2) abnormal migration of those cells into the neighbouring tissue, attempts were made to isolate from the tars specific substances producing these results.

The method employed was to subject white blood-cells

to the action of various compounds for ten minutes at 37° C. Those substances which caused cell proliferation by division were termed *auxetics*, while those producing amoeboid movements in the cells, when acting in the presence of auxetics, were described as *kinetics*. About thirty-one compounds (including creatinine, xanthine, methylamine, and leucine), which acted as auxetics, were discovered, while the kinetics included cadaverine, choline, and atropine.

Moreover, it was found that, whereas gasworks tar and pitch contained both auxetics and kinetics, blast-furnace pitch contained only a small amount of auxetics and no kinetics.

Further experiments upon the isolation and separation of the active substances in gasworks coal tar have recently been published by Mr. D. Norris (*Biochem. Journal*, 1914, VIII, 253), who has found that the auxetics are bases present in the anthracene fraction of the tar. They may be separated by shaking the tar with dilute hydrochloric acid, and treating the acid extract with ammonia, which precipitates them. They combine with picric acid to form insoluble picrates, one of which melts at 199° C., and has the composition $C_{22}H_{14}O_9N_6$.

On exposing an aqueous extract of the tar to the air its auxetic activity rapidly disappeared, and the tar could also be rendered inert by heating it to 160° C. and subjecting it to a current of air or ozonised air. This simple method of removing the dangerous constituents from the tar has been patented by Dr. Ross (Eng. Pat. 11,984 of 1913).

Another method claimed to destroy the auxetic activity of the pitch is to treat it with formaldehyde. This has been made the subject of two English patents by Mr. Robinson, and is being tried on a large scale at briquette works in Cardiff.

GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

GEOGRAPHY OF THE WAR AREA.—In an article, entitled "Some Rough War Notes" (*Geog. Jour.*, October, 1914), Professor Lyde gives an interesting summary of the geographical conditions of the parts of Europe contained in the present war area. The critical area in the western theatre is the "north-east quadrant of the Paris basin." Here there is the same succession of Mesozoic and Tertiary sediments as in the south-east of England, save that the dips trend westwards, and the steep escarpments face the east. Many of those towns, now familiar, in name at least, to everyone as the scene of conflicts, command gaps in the chalk or limestone. Further east the ground is more difficult, but even the hill forest of Argonne is no longer such an obstacle to armies as it was during the French Revolution, as much of it has now been cleared and drained. The valleys of the Upper Meuse and Moselle, with their tortuous courses and liability to floods, and the broken wooded nature of the country present greater obstacles. Professor Lyde discusses briefly the natural barriers of this region, and comes to the conclusion that the Rhine is the only good frontier, although it is not a good military or political barrier.

The internal divisions of the German Confederation are also considered, and the suggestion made that the unity is one "of economic interest rather than of political kinship." Apart from the peoples west of the Rhine, there are, from an ethnic point of view, several other "loose" units. The inhabitants of the Weser basin are closely related to the Danes, not only physically, but also with respect to religion, being strongly Protestant. The Vistula basin, again, is occupied by Poles (save in East Prussia, where the people are essentially Prussian), who are mainly Roman Catholic.

The conditions in the interior of Germany, and on the Austrian border, are more complicated. From Posen, on the Oder, to the Upper San valley the country is an alternation of marshes and reclaimed lands of great fertility. The foodstuffs produced by this area and the oil of the Galician wells become exceedingly important under modern conditions of warfare, while, in addition, there is an abundance of transport facilities, with Przemysl as the natural centre of the system. Bohemia, though comparatively isolated by natural boundaries, is, nevertheless, an excellent supply base owing to its fertile soil and mineral wealth. This is more obvious when the manufacturing districts of South Germany are considered. Here there is such a dependence for foodstuffs on external supplies that the whole region must capitulate as soon as its access to the outer world, chiefly by the Rhine, is cut off. These parts, the Schwarzwald, the Rauhe Alps, the Hessian Woodlands, are occupied by the best of the Teutonic types; but, despite their industrial organisation and scientific agriculture, the sandy plains are not sufficiently fertile to feed their population, while the richer areas of the lower Rhineland are given up to vine and tobacco cultivation. The only other access to foreign markets is through the region of the Middle Danube. This route, however, is much less important, as the areas surrounding the Hungarian Lowlands are occupied by a heterogeneous mass of people, who not only differ widely among themselves in political and economic interests, but are also fiercely antagonistic on religious grounds—one group belonging to the Greek Church and another to the Roman Catholic Church. The dominant class, however, is composed of the Magyars, who are Protestant, and who, though of Asiatic origin, have assimilated so much that is good from their environment that they now form the best type in the region.

The author has appended a list of the published maps of the regions involved in the war.

ILL-FATED ARCTIC EXPEDITIONS.—Definite information has now been obtained of the extent of the disaster to the Stefansson Arctic Expedition. The "Karluk" was believed to be frozen in for the winter near the mouth of the Colville River, in Alaska, when a gale partly broke up the ice on September 20th of last year, and caused the boat to drift in a westerly direction. The drifting continued until January 11th, when the ship was struck by an ice-sheet and so seriously damaged that it sank, about eighty miles north-east of Wrangell Island. A map in the July *Bulletin* of the American Geographical Society indicates the direction of this eight-hundred-mile drift, first in a general north-west direction and then south-west. Captain Bartlett made his way to Wrangell Island, and thence across Long Sound to Siberia, finally reaching St. Michael, in Alaska. The United States revenue cutter "Bear" rescued eight members of the expedition on Wrangell Island. Of the remainder three, including Mr. Mallock (geologist) and Mr. Maken (topographer), died on the island. Four, including M. Beuchat (anthropologist), Dr. Mackay and Mr. Murray (biologists), did not reach the island. While they may possibly be on Herald Island, which neither the "Bear" nor another vessel which made the attempt, could touch owing to bad weather, it is probable that they did not survive the ice journey. The only surviving scientific man is Mr. McKinlay (meteorologist).

Sedoff's Expedition, which left Russia in August, 1912, for Franz Josef Land, has also met with disaster, as the leader, Captain Sedoff, died of an illness north of Franz Josef Land in March, 1914. Sedoff's vessel has rescued the survivors of the Brussiloff Expedition, which left Petrograd in the summer of 1912. Eleven members left the boat at Franz Josef Land, and nine of these died at various places between there and Cape Flora, where the two survivors were picked up by Sedoff's party. Nothing further has been heard of the remainder of the expedition; but, as the boat is well provisioned, there is considerable hope that they will have survived.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE SATURATION OF MINERALS.—In the February number of "KNOWLEDGE" (Vol. XXXVII, page 69), a

paper, by Professor Shand, on "Saturated and Unsaturated Igneous Rocks" was commented upon in this column. The view was put forward that the saturated or unsaturated state of the constituent minerals with regard to silica was a natural basis for igneous rock classification. The criterion of saturation was the capability of co-existence of the mineral with free silica, as determined by the observed facts of distribution.

Mr. A. Scott questions the validity of this criterion in a paper on "The Saturation of Minerals" in *The Geological Magazine* for July. His main point is that "so many factors, external and internal, influence the cooling of a rock that in many cases the resultant solid is not in a condition of maximum stability." Consequently, rocks which have had different "cooling histories" are not comparable in respect to saturation. Many minerals only form within a certain range of pressure and temperature, being stable for these conditions and unstable for others. Yet the vicissitudes attending crystallisation may be such that the mineral survives under a subsequent unfavourable set of conditions, and may then be associated with other minerals in respect to which it is unsaturated. Moreover, minerals such as the garnets, topaz, and so on, which require special conditions for their formation, cannot be said to be "saturated" or "unsaturated" in the sense that albite, nepheline, or leucite can be. Igneous rocks have such different cooling-histories that a natural or genetic classification cannot be based on the final mineralogical composition, or on such a factor as saturation with respect to silica, employed in the empirical fashion suggested by Professor Shand.

GRAVITATIVE DIFFERENTIATION.—In his most original and suggestive work on "Igneous Rocks and their Origin," Professor R. A. Daly, of Harvard, presents a useful conception of the process of differentiation whereby homogeneous magmas are broken up into two or more unlike parts. Differentiation may be conceived as consisting of two stages: a *physico-chemical* stage, in which the units of differentiation are prepared, and a *geological* stage, in which these units are segregated and arranged in their respective positions within the igneous mass. The units may be solid crystals, or liquid globules, or even liquid crystals, and they may be separated from the magma by means of crystallisation, or by the process known as liquation, by which the magma splits up into partially immiscible portions. The units thus formed may be concentrated at various places within the igneous mass, according to the conditions under which the process takes place. If the separation of the units occurs just before the consolidation of the magma, they may be frozen in place without any appreciable segregation. When the units are crystals this would give rise to a uniform undifferentiated mass of igneous rock. When, however, immiscible liquid fractions have been produced by liquation, the resulting magma constitutes an emulsion. A good example of an igneous emulsion is the rock known as quartz— or granophyric — dolerite, in which a doleritic fraction, consisting of lime-soda felspar, augite, and iron-ore, is well mixed with, yet quite distinct from, a granophyric fraction, consisting of quartz and alkali-felspar. When the units of differentiation are produced in a thinly liquid magma some time before its consolidation, the heavier units must tend to sink under the influence of gravity, thus becoming separated from the lighter units, and concentrated towards the lower levels of the igneous mass. The whole process may be illustrated in a homely way by the contents of some medicine bottles. When left standing, the liquid frequently separates into two or more layers, the heaviest of which collects at the bottom. An emulsion may be reconstituted by shaking the bottle. A similar sorting process may be demonstrated in many igneous masses. In Mull, for example, the officers of the Geological Survey have found three cases of gabbro masses which merge in an upward direction into granophyre. Here the quartz-dolerite emulsion mentioned above has clearly been left standing, and has separated into its unlike fractions, the heavier of which has collected towards the base of the mass. Many other examples of gravitative differentiation have been described, and have been interpreted by Daly and others on the lines indicated above.

A FURTHER DISCOVERY AT PILTDOWN.—According to a note in *Nature* of September 3rd, further excavations at Piltdown have yielded to Mr. C. Dawson and Dr. A. S. Woodward a second portion of a molar tooth of *Mastodon*, larger and more characteristic than the fragment formerly described. The new specimen agrees well with the teeth of *Mastodon arvernensis* from the Red Crag of Suffolk. As it is waterworn, it is clearly a derived fossil of earlier date than the Piltdown gravel in which it is found.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

CLOUD-BURST IN MALTA, OCTOBER 16TH, 1913.—Dr. Thomas Agius, the Director of the Meteorological Observatory at Valetta, has communicated to the *Bollettino Mensuale* of the Italian Meteorological Society an account of the remarkable cloud-burst which occurred in Malta on October 16th, 1913. At Valetta the total rainfall for the day was twelve and a half inches, of which, according to the self-recording gauge, six inches fell between 1 and 3 p.m. The greatest amount for the day measured in the island was 16·30 inches at Vittoriosa, the next highest rainfalls being 15·26 inches at Cospiqua, and 13·03 inches at Zabbar. The least amount measured in the island was 2·36 inches at Melleha. In the adjoining island of Gozo the rainfall on the day in question varied from 2·04 inches at Kala to 0·44 inch at Garbo.

THUNDERSTORMS IN THE SUDAN.—In "KNOWLEDGE" for November, 1913, reference was made to some particulars about thunderstorms in Egypt, which Mr. E. W. Bliss had given in the *Cairo Scientific Journal*. He has since collected similar data for the Sudan. The few thunderstorms which occur in Egypt generally come in spring and autumn; in the Sudan, on the contrary, thunderstorms are very frequent during the months of July to October, During the last five years, 1909–13, the total number of days on which thunder or lightning was reported was as follows:—

Wadi Halfa.....	2	El Obeid	173
Merowe	42	Gallabat	62
Atbara.....	10	Roseires	42
Kassala	211	Wau	20
Khartoum	167		

As regards the diurnal variation, the maximum number of thunderstorms occurs at all stations between 6 and 10 p.m. This is also the time of the maximum number in Egypt.

TESTING ANEROIDS FOR USE ON AËROPLANES.—In the Report of the National Physical Laboratory some interesting particulars are given respecting the testing of aneroids and barographs. A special test was made on an aneroid for use on an aëroplane. This instrument was necessarily very light. It was the only one of its kind tested during the year, and it was found to behave satisfactorily. For decreasing pressure, the errors were found to be within ± fifty feet at all points tested. Two barographs have been tested at the Laboratory. They were both sent by the Royal Aëro Club, and showed records of the pressure registered during flights in aëroplanes. The examination of these instruments is rather interesting, and so the procedure may be worth mentioning. The instrument is received at the Laboratory in exactly the same state as it was found on the aëroplane after the completion of the flight, except that the pointer had been lifted from the paper. The clockwork is set going, and the instrument placed in the receiver of the aneroid testing apparatus, in which the pressure is adjusted so that the pointer falls on the beginning of the trace. As the drum revolves the pointer is made, by suitable variation of the

pressure, to follow closely over the trace made during the flight. At intervals along the trace the corresponding true pressures are read on the standard-gauge barometer. In this way a very accurate estimate of the true pressure corresponding to the maximum point on the trace can be made. To arrive at the actual height reached above ground level, it is necessary to know the following data: (1) The place of ascent and its height above mean sea level; (2) the date and hour of ascent; and (3) the difference between the pressure at ground level and that at the maximum height. The particulars given under (1) and (2) are referred to the Meteorological Office, to ascertain as closely as possible from their records the atmospheric conditions at the time and place of flight. Item (3) is got direct from the calibration of the barograph at the Laboratory. The information necessary for calculating the maximum height attained is then complete. The degree of accuracy to which the height can be certified depends partly upon the closeness of the barograph scale and the thickness of the trace and partly on the amount of information available as to the atmospheric conditions at the time of flight. For the two instruments tested the results were given to ± two hundred feet.

BRITISH RAINFALL, 1913.—The fifty-third annual volume of *British Rainfall*, which has been published at an earlier date than in any year since 1902, contains records of rainfall from five thousand three hundred and seventy stations, an increase of ninety-eight over the previous year. The greatest amounts of rainfall in 1913 were: 183·25-in. at Loch Quoich, Inverness-shire; 167·00-in. at Crib Goch, Snowdon; and 165·44-in. at The Stye, Cumberland; and the least amounts of rainfall were: 16·67-in. at Crowle, Lincolnshire; 16·96-in. at Cambridge; and 17·07-in. at Guthram, Bourne, Lincolnshire.

An exceptional fall of rain occurred in the neighbourhood of Doncaster during a thunderstorm on September 17th, when 6·43 in. fell in 14 hours.

For the British Isles as a whole the general rainfall was almost exactly equal to the average, as the extensive moderately wet areas in the west and the extremely dry east coast strip counterbalanced one another.

In one of the special articles Mr. R. C. Mossman gives the results of a fresh discussion which he has made on the occurrence of heavy rains in short periods by including falls up to two hours. The total number of cases dealt with was one thousand four hundred and forty-one, spread over the forty-six years 1868–1913. Taking the country as a whole, the maximum frequency is in July, during which month one third of the total number of cases occurred. This is equally true of all the other districts of the British Isles, except Scotland, where the maximum falls in August. The July maximum is most marked in Ireland, where forty-six per cent. of the cases took place in that month. In the north-east and north-west of England the values are also high, reaching forty-one per cent.; but in the south-east the frequency considerably diminishes to thirty-three per cent., while in the south-west of England the number in July has fallen to under twenty-eight per cent., and in Scotland to 24·5 per cent. The variations in frequency of heavy rains are doubtless closely related to variations in the frequency of thunderstorms in the different divisions of the country.

MICROSCOPY.

By F. R. M. S.

III.—THE COMMON EARWIG (*Forficula auricularia*).—(*Continued from page* 374.)—Another characteristic distinction between the sexes can be seen in the illustrations (see Figures 377 and 379) which have been produced under the same magnification. The ♀ insect appears shorter in length than the ♂, but in body, width, and segments it is larger, and, as mentioned before, the latter number seven in the ♀.

The ♂ in its shape appears thinner than the ♀, and the segments, numbering nine, are narrower in width.

In all other general features of appearance the two sexes are practically similar: the head, antennae, wings, and legs can be treated together, the following description applying to both sexes:—

The head of the insect is large in proportion to the body, and works on a distinct neck, which gives great freedom of motion; the former carries powerful mandibles and maxillae (biting jaws), strongly curved, ending in sharp teeth-like projections (see Figure 378).

The mandibles are simple in structure, and work in a condyle, this in turn working in a small cup to the various regions of the head.

The first maxillae, or second pair of jaws, are next to the mandibles, or first pair of jaws, and have a two-jointed basal part, which include the five-jointed palps, used for feeding and feeling, the two terminal parts of the latter being termed galea and lacinia, seen side by side. These palps are shown as organs with three joints in the illustration, one on each side of the head; the other parts are hidden behind the antennae bases.

The second maxillae, or third pair of jaws, known also as the labium, hang as a flap, and serve to close the mouth from behind, whilst its shield-like base is divided into a lower part (mentum) and an upper part (submentum). The three-jointed palps are fixed to the sides of the mentum, and parts answering to the galea and lacinia, as found in the first pair of maxillae, can be made out.

The labium really consists of a pair of appendages exactly similar to the maxillae, but the latter are fused together in the middle line.

We must remember that the jaws of insects and spiders, and so on, are really modified legs, differing in their origin and action from the jaws of vertebrate animals, working from side to side like a pair of scissors, and not up and down or backwards and forwards.*

The large compound eyes are present below the labial palps and antennae, bulging out prominently on each side of the head. It is remarkable and interesting to find that simple eyes, or ocelli, as found in many other insects, especially in the Muscidae (*e.g.*, House Fly), are entirely absent.

The antennae of both sexes, ♂ and ♀, are made up of large segments, which vary somewhat in size. The first segments at the base are very short; the succeeding segments become longer and continue about the same size towards the tips. These antennae are very long, and in both ♂ and ♀ appear to be the same in structure, presenting no points of difference as found in many other forms of insect life.

Each segment shows a conical formation, the base being much narrower than the apex; short, stiff hairs are sparsely scattered on their surface, and at the nodes these hairs become lengthened. In the illustrations (see Figures 380 and 382) it appears as if each segment were hollow, for a distinct thickening is visible on the outer walls, and connection from one segment to another is plain in that of the ♀ (see Figure 380).

The wings of the Earwig form a most interesting feature, and are seldom seen save during exceptional circumstances: they are of large size, semicircular in shape, and in texture are extremely delicate and filmy.

Under the very small elytra, or wing-cases, each wing is carefully packed away, held in place on the upper part of the thorax.

A small part of the wing is regularly exposed: the tip of the anterior margin projects more or less beyond the elytra, but the membranous portions are entirely concealed.

The delicate membrane of the wing is crossed by radiating lines, or veins, which commence from a horny plate occupying about a third of the anterior margin (see Figure 381).

* *Injurious and Useful Insects*, Miall, pages 14, 15.

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A little away from the origin of these veins the spaces between are cut up by a series of shorter veins, which run to the edge of the wing, and all the veins are united by a delicate vein which runs parallel to the outer edge. The extreme base of the wing is made up of several irregular cell-shaped spaces.

By means of the radiating veins, or lines, the apical and posterior parts of the wing can be folded like a fan, which is then doubled up under the horny margin of the base. The fan portion is capable of a transverse fold near the basal ends of the secondary veins; at various points these secondary veins and others are curved somewhat and slightly thickened.

In folding or unfolding the wings the Earwig uses its flexible abdomen by bending the latter forward over the back, and thus great assistance is given to the performance. Enock, in his wonderful account of these wings, shows how the marvellous process of unfolding and folding for and after flight is carried out in every stage.*

Owing to their nocturnal habits, Earwigs are seldom seen to fly, and the wings seem to be used with great reluctance during the day when the insect is disturbed.

Many Earwigs have been found adhering to newly tarred boards during night time, and in each case their wings were fully expanded. This suggests a ready way of capturing them.

The legs of both ♂ and ♀ are exactly the same size, and present the same general features when closely examined. The fore legs are small in comparison with the hind legs, whilst the middle legs form a medium between the two extremes (see Figure 383). The Earwig relies on its legs for escape, and they are particularly adapted for rapid locomotion, as can easily be demonstrated when the insect is disturbed in its retreat.

Each pair of legs is attached to a segment of the thorax, and each leg is divided up into five distinct parts, as found in all the insect family.

We have first the coxa (Latin, hip), or basal joint, which appears to be rounded on its broad sides; thus each leg increases in length as we pass from the first to the third leg. Adjoining the coxa is the trochanter (Greek, =a runner), a small piece connecting the coxa with the femur, or thigh, the latter being considerably elongated, and at its base covered with long, stout hairs (see Figure 384).

The tibia, or shank, the fourth joint in the leg, is also elongated, but much shorter in length than the femur. On its inner edge it is thickly covered with a heavy fringe of stout hairs, which appear to be equal in length.

The tarsus, or foot, is composed of two parts, the first being very short and circular in shape on its inner edge, while at the base are two small protuberances, sparsely covered with a few short, stout hairs.

It is interesting to note that in its near relative, the Cockroach, the tarsus of the latter is made up of five distinct portions, diminishing in size towards the claws, whilst the Earwig has the last portion of the tarsus considerably lengthened, and nearly equal to the tibia. The small protuberances present are no doubt aborted segments of the tarsus, and the long fifth segment is an abnormal development of this portion.

This fifth segment, or ungula, terminates in two sharp-pointed claws, which are worked independently of one another by means of powerful muscles.

W. HAROLD S. CHEAVIN, F.R.M.S., F.E.S.

PHOTOGRAPHY.

By EDGAR SENIOR.

SILVERING MIRRORS FOR PHOTOGRAPHIC PURPOSES.—While many formulae have from time to time been published for silvering mirrors, the technical difficulties attending the production of a silvered surface having such qualities as permanence and adherence are, as a rule, very considerable. Experience has shown that, although it is fairly easy to obtain a perfectly satisfactory silvered surface on blown glass, considerable difficulties are encountered when dealing with surfaces of polished glass, more particularly when the coated side is required to act as the reflecting surface, as in this case the high polish necessary to be given to the silver coating is difficult to produce on account of the soft nature of the deposit, and it is scarcely possible to obtain it without showing scratches. On this account it is found desirable to use a process of silvering that gives a highly reflecting surface without requiring to be polished. Methods of silvering in which formic aldehyde are employed, while they give very even reflecting surfaces, are, at the same time, somewhat unreliable. In Eder's *Jahrbuch* for 1913 a method of silvering glass is published which, according to the experience of Dr. Miethe, yields mirrors in which the silver deposit is both lasting and highly adherent, while, at the same time, it has the maximum reflecting power. It is also stated that great purity of the chemicals employed is not essential, and that such excessive care in obtaining a chemically clean glass surface is not required.

For the preparation of the silver solution the following formula is recommended:—

No. 1.

Silver nitrate	30 grammes (463 grains)
Water (distilled).....	900 c.c. (31·5 ounces)

No. 2.

Caustic potash	20 grammes (309 grains)
Water (distilled).....	900 c.c. (31·5 ounces)

The above solutions having been prepared, seven hundred and fifty cubic centimetres (26·25 ounces) of No. 1 are put into a bottle and ammonia added, drop by drop, until the precipitate first formed is just redissolved, when the whole of No. 2 is slowly added with constant shaking between each addition, in order to avoid the formation of a coarse precipitate. The resulting mixture has a deep brown opalescent appearance, and must be constantly shaken, while a further addition of ammonia is made, drop by drop, until a bright, clear solution is obtained, care being taken to avoid any excess of ammonia. The remaining one hundred and fifty cubic centimetres (five and a quarter ounces) of No. 1 is then added, when the liquid again assumes a brownish opalescent appearance; it is then filtered and kept ready for use in silvering. After an hour or two a small quantity of a black precipitate begins to deposit, but this does not affect the silvering, providing the solution is either filtered or the clear portion drawn off for use; and it is found that old solution works just as well as fresh. A certain amount of care should be exercised in keeping and handling the solution, as it has been found on occasion to explode with sufficient violence to break the bottle into small pieces. As a reducing agent we can employ either grape sugar or inverted cane sugar, the latter being prepared as follows:—

Lump sugar	25 grammes (385¾ grains)
Tartaric acid	3 ,, (46 ,,
Water	250 c.c. (8¾ ounces)

The solution is brought to the boiling-point, and kept at this for from ten to fifteen minutes, when it is cooled, and fifty cubic centimetres (one and three-quarter ounces) of alcohol added, when the whole is diluted to five hundred cubic centimetres (seventeen and a half ounces) by the addition of water. If preferred, a five-per-cent. solution of grape sugar may be employed as a reducing agent. The quantity of the reducing agent used in comparison with the silver solution has an effect upon the result; thus, if ten parts of silver solution to one part of reducing agent be employed, the silvering takes place quickly, but the silver is not clean and bright, and the deposit adheres badly, while, if the proportion of the reducing agent is about thirty per cent. of that of the silver solution, the most

* *Marvels of the Universe*, Vol. II, pages 1104–1108.

permanent and brightest coating is obtained. If the proportion of the reducing agent is still further increased, the silvering proceeds very slowly; and, although the coating has not such a fine surface, it is extremely even by transmitted light, and affords a very suitable means for the preparation of filters for the transmission of ultra-violet radiations. The method given above, however, is the one best suited to the silvering of glass required to be used as a reflector.

MANIPULATIONS IN SILVERING.—The glass to be silvered is laid at the bottom of a dish (preferably a glass one), with the surface to be coated uppermost, the silvering solution being allowed to cover it to a depth of at least eight or ten millimetres (one-third to two-fifths of an inch). During the process of silvering the dish should be rocked continuously, and the solution, which quickly assumes a golden-yellow colour, begins to deposit silver after about twenty or thirty seconds. The surface of the glass becomes coated with a deposit, which at first is of a bluish colour; this quickly changes to a silver grey, and, finally, a metallic surface is seen to form. The dish being constantly rocked, the silvering process is allowed to proceed until the silver is seen to deposit in small particles, which gradually increase in size, and which would finally, if the action were allowed to proceed too far, cover the entire surface with a grey coating closely resembling leather. However, before this stage is reached the operation must be stopped at a point which has to be learnt by experience. Silvering for too short a time produces a deposit which is easily damaged; while, if the operation is continued for too long a time, the surface is dirty and of a poor reflecting nature. When the silvering operation is finished, the solution is poured off, and the surface washed with distilled water, after which a large tuft of cotton-wool, wetted with distilled water, is carefully passed over the silvered surface with a light, but gradually increasing, pressure. It will be found, after a few minutes, that the water is repelled by the silvered surface, when the remaining water is removed by the use of a sheet of filter paper gently applied by the hand. After drying off the last trace of water, a perfectly uniform and brilliant reflecting surface should be obtained. The mirror will then be ready for use without further treatment. If, however, a slight film of a bluish tint still remains, it may be removed by passing across the surface a pad of cotton-wool, covered with a piece of chamois leather freed from grease. If this is applied with a light pressure, the silver coating becomes perfect, and of the maximum reflecting power. Mirrors prepared according to the method above-described are found to remain perfect for a length of time if kept in a pure atmosphere; they are, of course, quickly affected by sulphuretted hydrogen, but they may be protected for months against the injurious influence of this gas if they are wrapped in paper which has been impregnated with acetate of lead, or they may be stored in a box, the lid of which has been covered with paper of this nature. When, in course of time, the mirror becomes tarnished, the only remedy appears to be to resilver it, as it is difficult to remove the tarnish without impairing the surface. Any attempt to clean the surface by means of a solution of potassium cyanide has the disadvantage of dissolving the silver deposit in parts. It has been stated that mirrors prepared by the process described retain their properties for a longer time than those that are prepared by most other processes, and that the method has further advantages over those generally used.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

POWERFUL ELECTROMAGNETS.—The most powerful electromagnets available up to quite recent times were of the Ruhmkorff pattern, and served very well for the demonstration and study of diamagnetism and magneto-optical rotation. In 1896 Zeeman, using a Ruhmkorff electromagnet, discovered the effect which bears his name. The magnetic field attainable in this apparatus, over a sufficient space to permit of Zeeman's experiments on the magnetic resolution of spectrum lines, was about twenty thousand gauss, or twenty thousand lines of induction, per square centimetre. In 1894 Du Bois had published his design for an improved magnet of a circular shape, which gave a much stronger field, and this apparatus soon began to replace the older type, but was itself largely superseded by the semicircular pattern of Du Bois, which has been still further improved. With these improved electromagnets a field of forty-five thousand gauss may be readily obtained through a limited space. When magnetic fields much stronger than this are desired the expense of construction and power consumed become excessive. Perrin suggested in 1907 the use of liquid air for cooling the magnet coils, but the suggestion, so far as I know, has never been carried out. In 1909 Weiss designed a magnet with solenoids of copper tape in paraffin oil cooled by water coils, which gave a field of forty-six thousand gauss. Weiss has also employed water-cooled copper tubes as conductors. About 1909 Du Bois, by increasing the number of ampère turns on his semicircular magnets, obtained a field of nearly fifty thousand gauss; by employing extra coils close to the air gap even this field could be exceeded. The more nearly the iron of the magnet is saturated, the greater the benefit from these coils. Experiments by Ollivier in 1910 showed that by using long, straight cores without a yoke it is possible to obtain fields as high as forty-five thousand gauss. In 1911 Du Bois still further improved the design of his magnets, chiefly in the direction of providing greater facilities for their employment in different kinds of magnetic research. Weiss found in 1913 that a distinct improvement results from the employment of ferro-cobalt (Fe_2Co) for the tips of the pole pieces instead of Swedish iron. In January of the present year Deslandres and Pérot published descriptions of electromagnets in which the coils near the air gap in the Weiss and Du Bois magnets are given greater importance. The extra coils were kept cool by the circulation of chilled petroleum, and carried very intense currents (one thousand one hundred ampères). The resulting field was fifty-one thousand five hundred gauss. In March these authors announced that, by increasing the dimensions of their apparatus, they hoped to get a field of one hundred thousand gauss. In the *Comptes Rendus* for August 24th they advocate reliance on intense currents, and deprecate the use of large masses of iron. By the temporary employment of the resources of an electric-supply station in Paris they were able to get a field of fifty thousand gauss without the use of iron. The solenoids were made of silver tape, and were cooled by immersion in running water. These experiments have raised their ambition, and they now think that a field of one hundred and fifty thousand gauss is to be obtained by these methods, but the work has been stopped by the war.

PRODUCTION OF SOFT RÖNTGEN RADIATION —Two methods of producing very soft x-rays, i.e., x-rays of long wave-length, are described by Sir J. J. Thomson in a paper in *The Philosophical Magazine* for October. There is a gap of about eight octaves between the softest characteristic x-radiation yet investigated and the shortest known waves of ultra-violet light. These very short light-waves are about 9×10^{-6} centimetres long, while the longest x-rays have a wave-length of $3{\cdot}6 \times 10^{-8}$ centimetres. By the study of waves intermediate in length Sir J. J. Thomson hopes to find out the details of the arrangement of the constituent electric charges of the atoms. The first method given in the paper is not only a means of getting x-rays of a previously unknown type, but is also a new method of obtaining x-rays. Hitherto the only way has been to generate them by the impact of cathode rays. It now transpires that positive rays will also yield x-rays when they strike a solid. These x-rays are of a very soft kind, that is, they are not penetrative, and have presumably a relatively

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great wave-length. The apparatus used in the first method allows the positive rays to pass out of the part of the vacuum tube, where they are formed, through a long perforation in the cathode. After passing between a pair of insulated metal plates the positively charged particles strike a platinum target. The soft x-rays, which have their origin at the point of impact of the positive rays on the target, traverse a side tube sealed on to the main vacuum tube; and, after passing between a similar pair of electrodes to that between which the positive rays passed, strike a specially prepared photographic plate. This plate is in the vacuum tube, and is placed at right angles to the length of the side tube. Each pair of insulated plates is provided with means by which a strong electric field can be set up in the space between the plates. The photographic plate is partially screened by a metal plate, with a slit in it to give definiteness to the image. By noting the effect of putting on the electric field in the space between the electrodes, it is shown that the resulting photographic effect is really due to x-rays, and not to any other type of radiation. This new x-radiation has a very small penetrative power. The thinnest films of collodion, mica, paraffin wax, and white fluorite are opaque to it: it differs from harder x-radiation in being capable of ordinary reflection.

In the second part of the paper a method of making x-rays of a graduated scale of softness is described. Cathode rays in great quantity are obtained from a white-hot baryta-covered platinum cathode. These pass through a hole in the anode, and strike a target of copper, which is in electrical connection with a layer of gauze, through which the cathode rays pass on their way to the copper target. Variation in the speed of the cathode rays hitting the target is produced by the cathode particles being repelled by the gauze after passing through the anode; to effect this the gauze is given any desired voltage below that of the anode. If v_1 is the voltage driving the cathode ray tube, and v_2 that between the anode and gauze, the speed of the rays striking the target is proportional to $v_1 - v_2$. A side tube and photographic plate are used as in the first apparatus; the effects produced on the plate are shown to be due to very soft x-rays. By altering the speed of the cathode rays from the slowest, which will excite any detectable radiation up to that due to a few hundred volts, x-radiations gradually changing in penetrative power are excited. With very low speeds the resulting rays are unable to pass through the thinnest films of collodion, and other solids; but as the speed of the cathode rays increases, so does the penetrative power of the x-rays to which they give birth.

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

COLLOIDAL SOLUTIONS OF THE RADIO-ELEMENTS.—The first step in our knowledge of the existence of these solutions was taken by Paneth (*Kolloid-Zeitschrift*, Vol. XIII, page 1), when he was experimenting on a mixture of the members of the radium slow-change active deposit. Radium-D, -E, and -F were dissolved in a neutral solution, contained in a vessel of parchment-paper or of animal membrane, and it was found that, when this vessel was surrounded by pure water, the radium-D and -E could pass through its walls, but that there was no radium-F (polonium) in the external liquid. The particles of polonium had not been able to penetrate the membrane. He therefore came to the conclusion that this experiment was analogous to the dialysis of a mixture in solution of colloidal silica and hydrochloric acid. The acid can pass through because it is crystalloidal, but the silica cannot because of its colloidal nature. In neutral solution, therefore, radium-F is present as a colloid. The same worker then attempted, in collaboration with von Hevesy, to determine the number of simple radium-F atoms that were joined together to form a colloidal particle. It is well known that in ordinary colloids the aggregation of molecules making a colloidal particle is very great. The method adopted depended on the fact that in excess of the acid ion the velocity of diffusion of the metal ion was inversely proportional to the electric charge on that ion. In this way it was found that these colloidal molecules of the radio-elements contained at the most eight simple atoms. These results have received independent support from the experiments of Godlewski, working with entirely different methods. This work was based on the results obtained by electrolysing a pure-water solution containing radium emanation. He found that under these conditions a large fraction of the activity due to the active deposit was obtained on the anode, while in an acid solution the activity is found on the cathode electrode. He therefore concluded that radium-A (known to be analogous to polonium) was not present in the ordinary ionic condition, but as a colloid.

HYDROGEN α-PARTICLES.—It has long been recognised that the α-particles emitted by uranium, radium, and other radio-active bodies consist of atoms of helium, of atomic weight 4, carrying two unit charges of positive electricity. One property of these α-particles is that, when one strikes a zinc sulphide screen, a flash of light is produced which can be seen with the aid of a microscope. When emitted, they have a speed of approximately 2×10^9 centimetres per second. When this speed falls below a certain critical velocity the atom ceases to be an α-particle, and becomes an ordinary helium atom. When α-rays go through a quantity of hydrogen (unit atomic weight) the speed acquired by hydrogen atoms that have been in collision with them must be very great, and it seems reasonable to expect, from considerations stated by Bohr (*Philosophical Magazine*, Vol. XXV, page 10), that the "range" of such hydrogen particles should be four times the "range" of the α-particle producing them. These have been called "H" particles, and their existence has been shown by Marsden in a recent number of the *Philosophical Magazine* (May, 1914). The apparatus initially employed was very simple, and consisted of a glass tube, of about one metre long, closed at one end by a zinc sulphide screen, viewed with a microscope. A strong source of α-rays was fixed to a small iron stand, which could be moved along the tube by a hand magnet operated externally. When the apparatus was closed and filled with hydrogen it was found that scintillations could be observed on the zinc sulphide screen long after all the original α-rays had been absorbed by the hydrogen in the tube. Additional experiments were made which showed that these scintillations could be produced by hydrogen alone, and that they were therefore due to "H" particles.

THE ORIGIN OF THE γ-RAYS.—These very penetrating rays have for many years been recognised as due to vibrations produced somewhere within the atom. They are thus quite distinct from the α- and β-rays, which are both produced by the expulsion of a small part of the atom itself. Rutherford has put forward the suggestion that the γ-rays are caused by the passage of a β- or α-particle through a ring of electrons situated in the interior of the atom. The electrons in this ring are quite distinct from those governing valency and ionic phenomena. As is well known, β- and γ-rays are closely associated, whereas, on the above assumption, one would expect a much greater disturbance, and therefore the production of more γ-rays, to accompany the emission of an α-particle. Russell has shown that γ-rays are produced in these circumstances, but these rays are of exceedingly small importance. To explain an analogous case, namely, the absence of γ-rays in connection with the intense β-rays of radium-E, Rutherford (*Philosophical Magazine*, September, 1914) makes the assumption that the β-rays are always emitted in some direction fixed relative to the intra-atomic structure, and that the γ-rays can only be set up in certain limited regions. γ-rays, on this assumption, only accompany the β-rays when these

latter " pass through or near a region where characteristic (γ) radiations can be set up."

This is another reason for leading us to believe that the nucleus of the atom has a complex structure, just as the atom itself is complex.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

HOW A MOULTING LOBSTER WITHDRAWS THE MUSCLES FROM ITS CLAWS.—In their interesting and beautifully illustrated book on " The Animal Life by the Sea-shore " (1914), Drs. G. A. and C. L. Boulenger make an instructive note on the way in which the lobster (or any similar Crustacean) gets the muscles of the big claw through the narrow basal segment. Just before the moulting " the water and blood which swell the muscular part are withdrawn, and cause the tissues to shrivel up to such an extent as to allow of its being forced through a narrow opening." After the moulting the muscle soon becomes turgid again, the proportions are restored, and the claw is bigger than ever. The authors give a diagrammatic sketch, showing how the fleshy part shrivels before the moult.

REMARKABLE EPIZOIC OLIGOCHAETE.—A peculiar little worm, with a surprising mode of life, was found by Major Kelsall in Sierra Leone, and is described by H. A. Baylis. It lives attached to the outside of a large (unidentified) Earthworm, and belongs itself to the Earthworm (Oligochaete) stock. The posterior half of the body is flattened and expanded into an oval disc, bearing numerous transverse rows of ventral bristles. The total length was five millimetres, and the specimens were sexually mature. As the food canal contained earth and vegetable débris, it seems probable that the small worm uses the large worm simply as a means of transport. Mr. Baylis proposes the name *Aspidodrilus kelsalli* for this interesting new animal.

DEEP-WATER SNAILS OF THE LAKE OF GENEVA. In the shore area of the Lake of Geneva there are four species of ***Limnaea***, viz., *L. stagnalis*, *L. palustris*, *L. auricularia*, and *L. ovata*. They are mainly vegetarian, and they breathe air at the surface of the water. In the depths of the lake, down to one hundred metres, there are two species, *L. profunda* and *L. abyssicola*. They are mainly carnivorous, and they breathe cutaneously. Compared with those of the shallow-water area, the deep-water forms have rather smaller eyes, though not in any way degenerate, and they seem to be less prolific. Now, by making a very careful comparison of specific characters, and taking due account of varieties, W. Roszkowski has convinced himself that the deep-water forms are not worthy of being regarded as distinct species, but are abyssal varieties of two of the littoral species. In short, *L. profunda* is a variety of *L. ovata*, and *L. abyssicola* of *L. palustris*; and it is not likely that the varieties were established until after the Glacial period.

EVOLUTION OF MAMMALIAN HAIR.—Mammals probably evolved from an ancient Reptilian stock, but from what did hairs evolve? Many answers have been offered, but none seems satisfactory. Hairs have been hypothetically derived from scales, from parts of scales, from touch-spots of Reptiles, from integumentary sense-organs in Amphibians, from pearl-organs in Fishes, and so on. All the views have been recently reconsidered by E. Botezat, who comes to the conclusion that hairs are *sui generis*, and that they were evolved by mammals without any affiliation to other structures in other vertebrates. He thinks it likely that the primary function was sensory, and the secondary function protective. In any case, there have been two main lines of hair-evolution in mammals, the one ending in the non-sensory, woolly hair, specialised for protection, the other ending in the mobile, tactile hair, or vibrissa, specialised as a sensory structure.

PATERNAL CARE.—Everyone knows that there are not a few examples of marked parental care on the part of male animals. Sea-spiders or Pycnogonids, Sea-horses, and Nurse-toads occur to one as good illustrations, and it is noteworthy that the cases are scattered here and there in the animal kingdom. The phenomena have been insufficiently studied. One would like to know whether some of the cases have evolved from a state of affairs in which the parental care was thoroughly bi-parental, as in some birds. One would like to know whether the instinct of caring for the eggs and offspring has been in some cases grafted on to the male sex, just as it sometimes appears as if certain masculine characters could be grafted on to the female sex. Witness the Red-necked Phalarope. One would like to know whether there is in any case some connection between the parental care and the sexual impulse. The subject demands further study. How quaint, for instance, is the case of the water-bug Zaitha, where the female, as Professor Abbott describes it, " seizes the weaker male, and, in spite of his struggles, glues her eggs all over his back, transforming him, for the time being, into a nurse."

SIDE GLANDS OF SHREWS.—It is well known that while cats will kill shrews, they never eat them. This is believed to be due to the repulsiveness of a secretion produced by a line of skin glands on each side of the shrew's body. It has a strong and characteristic scent, especially during the breeding season. Sigurd Johnsen has shown that the glandular lines consist of exaggerated sweat-glands, accompanied by sebaceous glands, which may also be exaggerated. The odoriferous secretion is due mainly, if not exclusively, to the activity of the sweat-glands, and this activity waxes and wanes with the reproductive activity. While the sebaceous glands go on increasing during the shrew's short life of a couple of years or so, the sudorific glands of the lateral organ attain their maximum at sexual maturity. It seems likely that the glands have come to be connected with sex, and that the odoriferous secretion helps the animals —solitary and nocturnal—to find one another. This is not inconsistent with the view that the odour may also be protective. Johnsen found the lateral organs developed in *Sorex araneus*, *S. minutus*, *Neomyo fodiens*, *Crocidura murina*, and *C. leucodon*.

MALAYAN PANGOLIN.—W. Schultze contributes some interesting notes on a specimen of ***Manis javanica***, which he kept in captivity for three weeks. It fed on arboreal termites, which make large hard nests on the trees. The pangolin first removes the outer brittle layer from one side, and then hollows out the very hard interior, breaking it away piecemeal by inserting its claws into the passages or cells, and using them as levers. When it reaches the termites it keeps its tongue busy. It often hollows out the nest so that the general shape is left. The nests are from twenty to fifty centimetres in diameter, and the captive pangolin emptied four of medium size in one night.

The pangolin seems to have poor eyesight, at least during the day. It seems to depend on scent. When liberated tentatively, it always made for the nearest forest or thicket. It never turned towards open places or the sea. If disturbed when walking about, it quickly put its head between its fore legs, turned a somersault, and rolled itself up into a ball, making a hissing noise. Its tail, which has a horny pad at the end, is useful in climbing and in hanging on to the branches. The animal has a very peculiar odour.

A STRANGE HOME.—The contrast between free-living animals (Eleutherozoa) and fixed plants is vividly illustrated in Professor E. F. Gautier's description of a hill near Jelfa, in Algiers, which is composed entirely of rock salt. It reaches a height of over three hundred feet, and has a diameter of under a mile. Neither on the salt hill itself nor on the salt-impregnated clays on its margins is there any plant life, except in a few sink-holes, which are choked with alluvial deposits. In great contrast to this is the abundance

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of animal life, especially of birds and bats. The salt "mountain" is quite a bird-berg—for hawks as well as doves—which feed at a distance, but shelter and breed on the rock.

EMERODS, MICE, AND THE PLAGUE.—Professor D. Fraser Harris has a note on the view that the plague of 1 Samuel vi, 5 was bubonic plague, the word "emerod," or "haemorrhoid," referring in all likelihood to the buboes, tumours, or swellings in the region of the groin or elsewhere. The plague, or "Black Death," is now known to be due to a bacillus, discovered by Yersin and Kitasato in 1894, which also occurs in mice, rats, and marmots. Man is usually infected by being bitten by a flea which has been feeding on a plague-stricken rat or other rodent. The interest of the five golden mice which were made on the recommendation of the Philistine soothsayers is considerable, for it is possible that there was some glimpse of the truth that the overrunning of the land with mice was not unconnected with the plague of emerods. Professor Fraser Harris notes that "No rats, no plague," is an old saying amongst the people of India.

FRILLED SHARK OFF THE COAST OF BRITTANY.—Among the gristly fishes, the most archaic living type is the Frilled Shark (*Chlamydoselachus anguineus*), first described from Japan, but afterwards captured off Madeira, off the Azores, and off the coast of Spain, Portugal, and Norway. It is a rare deep-water fish, and its occurrence near La Rochelle is of great interest. It is reported on by Drs. J. Pellegrin and E. Loppé, who note its length as about five feet. The body is elongated; the mouth is nearly terminal; there are six gill-clefts; there is a hint of a gill-cover; in the posterior part of the trunk the notochord is unconstricted; the lateral line is an open groove. The characters of the Frilled Shark are well known, but almost nothing is known of its habits. It is the only representative of its family, Chlamydoselachidae.

HABITS OF HYRAX.—In a report on mammals from the Blue Nile Valley, Mr. Glover M. Allan has something to say about the habits of Butler's Hyrax (*Procavia butleri*). The animals live in dens among huge boulders, and often sit motionless at the entrance. When convinced of safety, they delight to bask in the sun in the early forenoon. They may also be seen running for a long distance from rock to rock, and then diving into a hole. Their enemies are leopards and other carnivores or predaceous birds; and in this connection it is rather surprising that they have a way of occasionally throwing aside all caution, and bounding a few paces from their holes of a sudden. "Perched on a boulder, they look about, or give a characteristic sharp bark of two syllables at short intervals for some minutes at a time." In fact, they show a rather curious combination of shyness and boldness.

NEW FAMILY OF AMERICAN GOATSUCKERS.—Harry C. Oberholser finds that the American Goatsuckers of the genus *Chordeiles*, and several related genera, must be separated from the Caprimulgidae and placed in a new family, Chordeilidae. The cranial characters are very distinctive. The detailed study is very interesting, for the genus *Chordeiles* includes only three specific types (with races), namely *virginianus*, *acutipennis*, and *rupestris*, which are trenchantly different, and are evidently genera in process of evolution. As to habits, the members of the genus *Chordeiles* are birds of the open country, strong-winged, insectivorous, and very beneficial. They spend much of their time in the air, and their great gapes are well suited for insect-catching. Their feet are weak, and not well adapted for perching. The birds usually crouch on the ground, on fence-rails, low branches, and the like. On a fence-rail they almost invariably sit lengthwise. They build no nest, but deposit their two well-mottled eggs on the ground or similar places. The young are practically helpless for some time after birth.

BRIGHT COLOURS OF MALE BIRDS.—One admires the courage, at any rate, displayed by Dr. J. C. Mottram in maintaining that the male bird "becomes brilliant in colour, in order that he may be more likely to be destroyed, and thus the dull-coloured female gain protection." We believe it to be true that some male birds try to distract attention from the nest; and we believe, as Darwin did, that variations may be established which are for the advantage, not of the individual, but of the race. But we cannot believe in Dr. Mottram's theory. Leaving aside the faulty teleological expression "becomes brilliant in colour in order that," we cannot get over the difficulty that the more effective the males were in being killed, the more the conspicuousness would tend to be eradicated from the race. But the author of the theory ingeniously suggests that the pairing would occur before death, so that the male would hand on the valuable quality of conspicuousness through the unaffected female line to his male descendants. "The conspicuous colour of the male serves to control natural selection in such a way that the less valuable male will be killed in preference to the more valuable female." This appears to us to be arguing in a circle, since we do not know of any absolute biological value. A character has only value in relation to the particular exigencies of the species, that is, in relation to the particular selection that goes on. It cannot, therefore, control selection.

OX WARBLE-FLIES.—The full-grown larvae of the Ox Warble-fly (*Hypoderma bovis*) leave the cattle and pupate in the ground. The flies emerge between the middle of June and the beginning of September. They have a very short life of, on an average, between four and five days. They do not eat at all. They fly quickly, but only in fine weather, and never far. A German observer, Gläser, saw a female lay five hundred and thirty-eight eggs on a cow in three-quarters of an hour, each on a single hair. A French observer, Lucet, found about three hundred and fifty ova in the abdomen of each of four flies. While Gläser attributes panic among cattle to the Warble-flies, Lucet placed the flies on and beside a calf, and observed no trace of fear or annoyance. Lucet found that an injection of iodine into the nodosities containing the Warbles killed the larvae without fail, and that subsequent absorption occurred without any suppuration—a fact of much practical importance. Professor G. H. Carpenter and Mr. Thomas R. Hewitt describe what Gläser has also seen, the newly hatched larva of *Hypoderma bovis*, a stage which has hitherto been missed. It is a tiny maggot with formidable mouth-hooks and with strong, spiny armature in seven or eight irregularly arranged rows of spines around most of the segments.

Gläser placed newly hatched larvae on the shaved skin of a calf, and observed that they made no attempt to bore through. This might be used as an argument by those who insist that the egg or larva must be swallowed by the cow or calf. But Carpenter and Hewitt found that muzzled calves, apparently unable to swallow either the eggs or young, were at the most but partially protected from infection. The strong mouth-hooks and piercer and the well-developed, spiny armature of the newly hatched maggot suggest that it could, perhaps, bore as readily through the skin as through the mucous coat of the gullet.

Moreover, Gläser had a curious experience. A maggot, hatched from an egg laid on his trousers by *Hypoderma lineatum*, bored through the skin of his leg and disappeared in an hour and three-quarters. Four or five days later the larva could be felt through the skin. This was in June. It apparently worked its way upwards, for early in September swellings were apparent on the hip and abdomen, and at the end of that month a swelling in the lower end of the gullet was indicated by pain when swallowing. On October 2nd Gläser had a two-fold satisfaction in extracting a Warble-maggot from his own mouth.

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FIGURE 377. The Earwig, ♀ (*Forficula auricularia*). × 7.

FIGURE 378. Head of the Earwig, showing mouth organs and head appendages. × 15.

FIGURE 379. The Earwig, ♂. × 7.

FIGURE 380. Antenna Segment of the ♀ Earwig. × about 80.

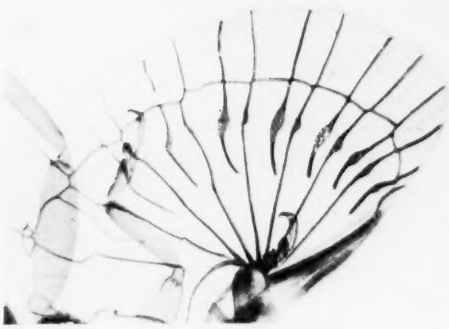

FIGURE 381. Left Wing of the Earwig, ♂, showing horizontal and vertical veins, and so on, attached to basal portion. × 9.

FIGURE 382. Antenna Segment of ♂ Earwig. × about 80.

FIGURE 383. The Legs of the Earwig. × about 10.

FIGURE 384. Hind Leg and Foot of the Earwig, ♂, showing hairs on the Tibia. × about 45.

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FIGURE 385.
An Ancient Egyptian Bow-drill. Rapid movement is produced with one hand, while the other is free to manipulate the drill. (*After Rosellini.*)

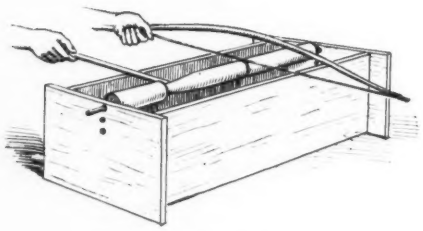

FIGURE 386.
A Persian Bow-lathe. The piece of work takes the place of the spindle in the bow-drill, and is horizontal. (*After Holtzapffel.*)

FIGURE 387.
An Archery Bow-lathe with treadle (eighteenth century). (*After Diderot and D'Allembert.*)

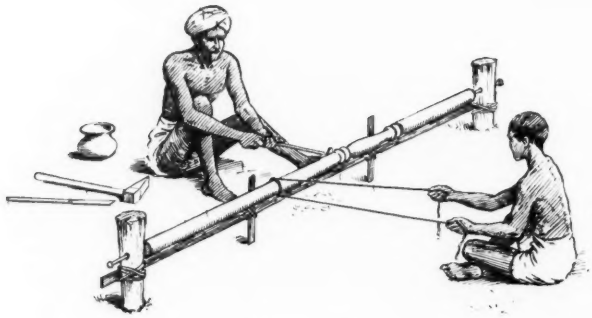

FIGURE 388.
An Indian Lathe with two workers. (*After Holtzapffel.*)

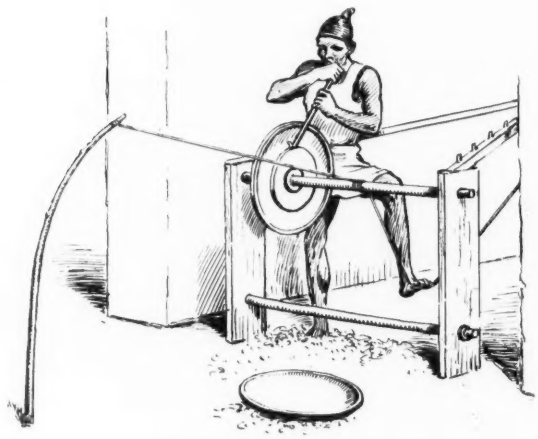

FIGURE 389.
A Kabyle Pole-lathe. (*After Knight.*)

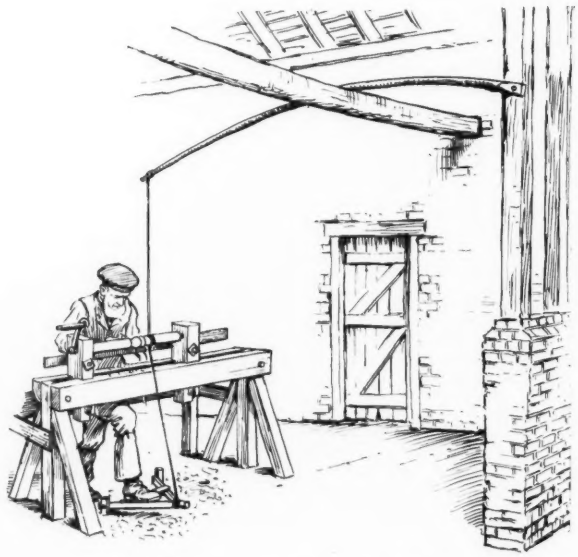

FIGURE 390. An English Pole-lathe.

THE POLE-LATHE.

By WILFRED MARK WEBB, F.L.S.

(*Continued from page 364.*)

In making an endeavour to follow out the development of the pole-lathe it will be well to consider what other simple methods are, or have been, adopted to make objects revolve backwards and forwards as a means to an end.

Nothing could well be more primitive than boring with a pointed flake of flint, or, for that matter, with a modern brad-awl, held in the hand and twisted first one way and then the other. The action is of necessity somewhat slow, but greater speed can be obtained by rubbing a stick between the palms of the hands, as is done by native races in the making of fire with the fire-drill. In this case it is not easy to put much pressure upon the instrument that revolves. A very ingenious device, which removes the drawback by leaving the hand free to hold down the drill, was invented in very early times. It consists in making a loop in a bow-string, and putting it round the drill, which is kept in place by the operator with one hand, while the other, by moving the bow backwards and forwards, causes the tool to revolve in alternate directions. Such a bow-drill was in use in ancient Egypt, and one is shown in Figure 385, which is taken from a monument. The head of the drill is pivoted on to the spindle, so that rapid movement can be produced.

To convert the bow-drill into a lathe is a very easy matter: all that is required is to turn it from the vertical into a horizontal position, and to pivot it at two fixed points. The Persian bow-lathe (see Figure 386) is about as simple as one could possibly be. The idea may have arisen through a desire to work upon the spindle of a drill which was temporarily placed in a horizontal position for the purpose. On the other hand, it is possible in the case of the lathe, where the material to be turned has no string round it, but is fixed to a mandrel, that the suggestion of making it revolve may have been given by a drill becoming fixed in an object while it was being bored, and this, as a consequence, being twisted backwards and forwards by the movements of the bow.

In the Persian lathe one hand is, of course, free to hold the tool, but to have both at liberty for this purpose would be better. In the Indian lathe (see Figure 388), by removing the bow altogether and putting a boy to pull the ends of the string alternately, the turner can take both hands to the tool.

It may be mentioned that the bow-lathe still survives, and is used in this country by jewellers when turning very fine work.

Another method of freeing the second hand is by bringing a foot into play. In the Kabyle lathe the string is only detached from one end of the bow, which is fixed firmly in the ground (see Figure 389). After passing round the spindle of the lathe, the string is fastened to a support at a little height from the ground, and, by pressing his foot on the line, the turner works his lathe. It will be noted that the latter is used for turning bowls or trays, and that, as in the English pole-lathe used for this purpose, the string does not pass round the actual work.

It is not a very big step from such an arrangement as the Kabyle lathe to one with a proper treadle. Figure 387 shows an archery bow-lathe, and Figure 390 an English pole-lathe, furnished with treadles. By this time it will have become clear that the pole of the pole-lathe is only an exaggerated bow fixed at one end, and the cord or strap fastened to the other—merely a thickened bow-string.

REVIEWS.

ASTRONOMY.

The Elements of Descriptive Astronomy.—By E. O. Tancock, B.A. 110 pages. 15 plates. 21 figures. 7¼-in. × 5-in.

(Oxford: The Clarendon Press. Price 2/6 net.)

The author in his preface says: "I have endeavoured in this book to give a simple description of the heavenly bodies and their motions in a form which should appeal to those who know little or nothing of the subject." We think he has achieved his object with marked success.

The book consists of fifteen chapters and a supplementary one of questions, fifteen plates of typical objects in the heavens, twenty-one good illustrations in the text, and is concluded with an index of those subjects given in clarendon type.

In reading the book we noticed a few errors or omissions, and we give two of them, so that they may be corrected in a future edition, of which we hope to see many. On page 51 the magnetic needle should be only 15° west, not nearly 20°; and in Chapter VI there is an inexplicable omission of any reference or statement to the fact that Saturn has satellites.

It is not easy to sum up Astronomy in about one hundred small pages, and be of practical use; but we think the author has given his descriptions of the elements of general Astronomy in simple, clear, and concise words; the examples

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are apt. He has written a really useful book, and one well adapted for teachers—who are themselves sufficiently acquainted with Astronomy—of children from about twelve years old.

The paper and printing leave nothing to be desired, and if the price could be made sixpence or one shilling lower the book should be in the hands of, or recommended by, all educational bodies.

F. A. B.

Publications of the Solar Physics Committee.—12-in. × 9¾-in. each memoir.

(Wyman & Sons.)

The work of the South Kensington Observatory is brought to a close by the issue of these three memoirs entitled :—

(I) "On the Spectra of the Rigelian, Crucian, and Alnitamian Stars; (II) The Line Spectrum of α Orionis; (III) The Spectrum of γ Cassiopeiae" (one volume).
41 pages. 3 plates. Price 3/6.

"Areas of Calcium Flocculi on Spectro-heliograms, 1906–08."
7 pages. 1 plate. Price 9d.

"On Some of the Phenomena of New Stars."
63 pages. 4 plates. 2 figures. Price 5/-.

All three volumes have been produced under the direction of Sir Norman Lockyer. The first by Mr. Baxandall consists of three papers, which form a continuation of memoirs dealing with the classification of stars based on their chemistry, as exhibited in their spectra. The classification is here carried further by the subdivision of the Alnitamian class. The next paper in this volume contains a detailed comparison of the line spectrum of α Orionis with that of Arcturus and the Sun, while the third gives a table of the wave-lengths, probable origins, and general description of the dark lines in the spectrum of γ Cassiopeiae.

The report on Calcium Flocculi, prepared by Mr. Butler, consists of tables and curves. The tables give the areas of the calcium flocculi in millionths of the Sun's projected hemisphere, while the curves show these areas, together with the areas occupied simultaneously by sun-spots.

In the paper on New Stars, Sir Norman Lockyer continues a communiciaton to the *Philosophical Transactions* of 1890, while the general conclusions to be derived from the whole work are deferred to a further memoir. It is impossible in a short note to do justice to the value and interest of this important research. We must content ourselves with briefly indicating some of the matters dealt with. It is shown that there probably exists a normal course of development of the light of a new star as shown in the spectrum. The spectrum rapidly passes through well-defined states, while the light rises to a maximum intensity and fades away again. The lines in the spectra are found in other celestial sources, and most of them have been tracked to their origin in known chemical elements. The distribution of new stars in space is very remarkable: they all seem to be very distant, and (with one notable exception) lie in those parts of the sky occupied by the Milky Way, its branches, or the Magellanic Clouds.

J. H. V.

BIOLOGY.

The Philosophy of Biology.—By JAMES JONSTONE, D.Sc.
391 pages. 9-in. × 5¾-in.

(The Cambridge University Press. Price 9/- net.)

This book, intended for the lay as well as the scientific public, will repay the most careful study, even though we may not see eye to eye with the author in all his conclusions. He is evidently one of an increasing number of scientific men who cannot reconcile some of the most important phenomena exhibited by organic beings with any mechanico-chemical law, and have come to the conclusion that to continue effort in this direction is but to plough the sand. Nevertheless, he recognises the value of work on this hypothesis, and rejects the theory of "vital force" as affording any intelligible explanation of the facts. The constructive part of his work seems to us far more satisfactorily accomplished than anything we have read lately. The appendix especially demands close attention, if the reader is to follow the doctrine of *entropy* and its application to the living organism. In any case it is a difficult idea to grasp. The accurate and comprehensive knowledge of the author, his clear thinking and mode of expression, render the book a most valuable addition to the literature of the subject, and it is indispensable to every biologist who is, or would like to be, something of a philosopher as well.

M. D. H.

Researches into Induced Cell-Reproduction in Amoebae.—By JOHN WESTRAY CROPPER, M.B., M.Sc., and AUBREY HOWARD DREW. Volume IV of the "John Howard McFadden Researches." 112 pages. 10 plates. 33 figures. 9-in. × 5¾-in.

(John Murray. Price 5/- net.)

It may be said at once that this book is one of extreme interest and importance to biologists. Experiments have shown that normal cell-reproduction and benign tumours are caused by certain chemical agents called "auxetics," such a tyrosin and creatin, and that cancerous tumours are caused by mixtures of auxetics with another group of substances called "kinetics" or "augmentors," such as choline and cadaverine.

The authors in this fourth volume of the "John Howard McFadden Researches" have not dealt with body cells, but with amoebae. The type employed is one for which the name *Amoeba ostrea* has been suggested; it was found growing in a sodium citrate and sodium chloride solution, which had been lying exposed to the air in the laboratory. The first part of the book deals with methods of examination, and, as shown in Figures 392 and 393, in order to prevent the cover-glasses from resting on the amoebae, they were dropped on to a piece of moistened fine-meshed muslin (chiffon) and then covered. A good deal of information with regard to the food of the animals is followed by an account of the action of auxetics and kinetics upon them. On the third day after treatment with asparagin (auxetic) the whole medium was swarming with minute free forms. These lengthened, and in twelve days had quite altered their type, becoming very long and slender. When creatine (auxetic) and choline (kinetic and augmentor) were used, it was found that the choline stimulated multiplication very rapidly. During prolonged work it was discovered that normal forms, when grown with augmented auxetics, became what is called "the radiosa type," consisting of a central body with long, blunt pseudopodia. In Type 2, which is the rarer (see Figure 391), the pseudopodia were very much longer, and thinned out to fine filaments. The second part of the book is occupied with the results of experiments on the causes of excystment and excystation. The third deals with the preparation of cultivations, consisting of one species of amoeba with a pure strain of bacterium. Incidentally, it is shown that amoebae prefer certain bacteria as food. The last chapter consists of the description of a parasite of amoeba which was discovered by Mr. Drew. It consists of a peculiar black diamond-shaped body, with a central dot, which moves sluggishly about in the endoplasm of the animal; and, while the volume was in the press, it was found possible to infect cultures of an amoeba obtained from pond water, and apparently also two flagellate infusorians. The parasite appears to be a large *Micrococcus* resembling *M. ochraceus*.

W. M. W.

BOTANY.

The Story of Plant Life in the British Isles.—By A. R. HORWOOD, F.L.S. Volume II. 358 pages. 78 illustrations. 8-in. × 5-in.

(J. & A. Churchill. Price 6/6 net.)

In the Spring we were pleased to give a word of praise to the first volume of Mr. Horwood's book, and now the second

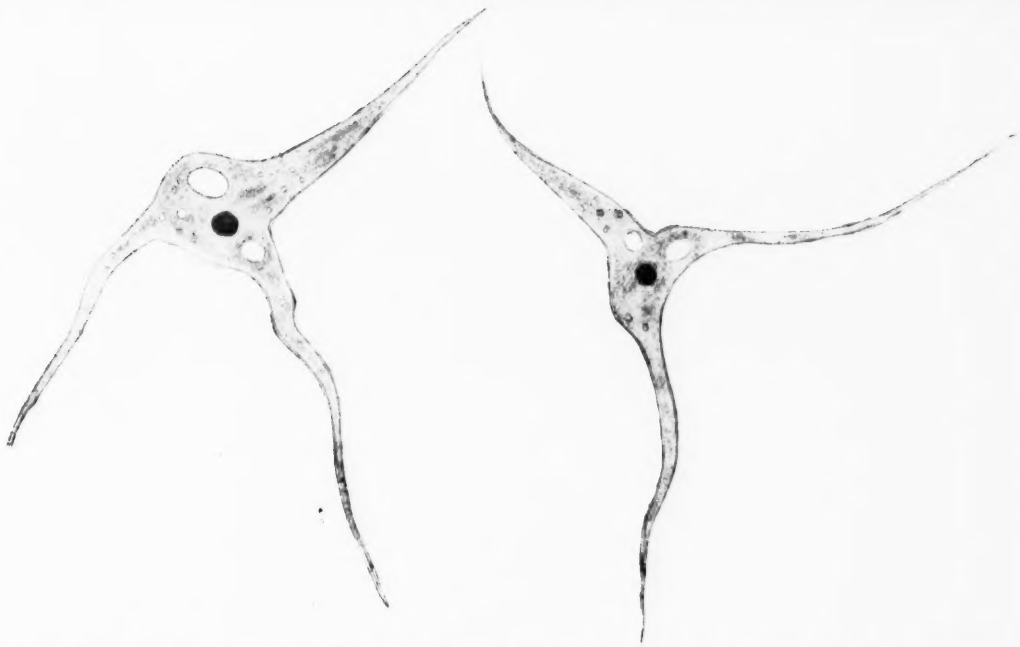

FIGURE 391. Radiosa type No. 2 of Amoebae after eight days in a mixture of equal volumes of creatine (0·5 per cent.) and choline (0·5 per cent.).

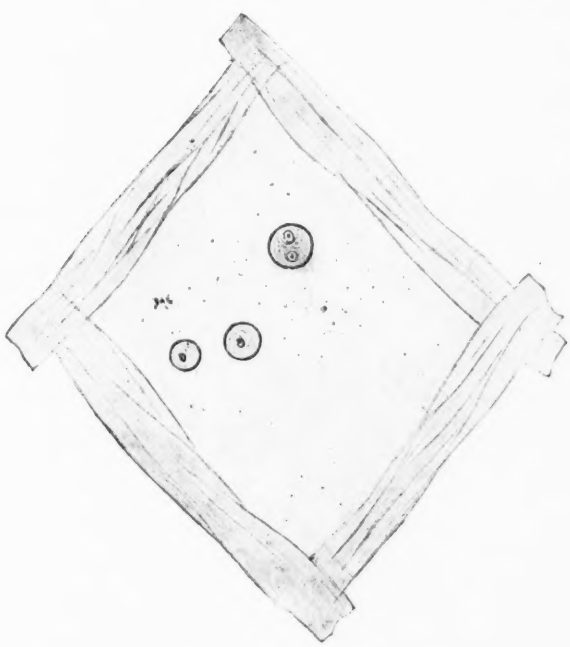

FIGURE 392. Amoeba Cysts.

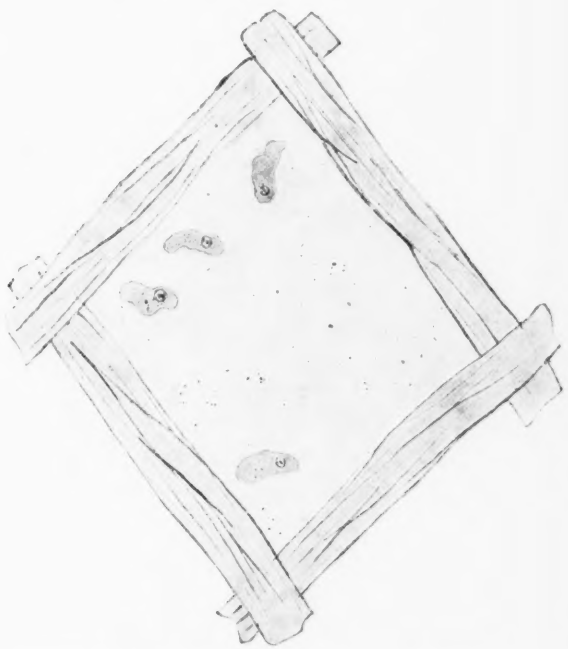

FIGURE 393. Amoebae which have escaped from the cysts.

The specimens are lying between the meshes of a piece of thin muslin spread on a glass plate. They are under conditions which are suitable for the continuous observation of Amoebae with high powers of the microscope.

(From "Researches into induced Cell-reproduction in Amoebae," by J. W. Cropper and A. H. Drew. By the courtesy of Mr. John Murray.)

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From a photograph by *Flatters & Garnett.*

FIGURE 394. Rockrose (*Helianthemum vulgare*).

From a photograph by *J. H. Crabtree.*

FIGURE 395. Honeysuckle (*Lonicera Periclymenum*).

(From "The Story of Plant Life in the British Isles," Volume II, by A. R. Horwood, F.L.S. By the courtesy of Messrs. J. & A. Churchill.)

lies before us. It is, in the main, on the same lines as its predecessor, and the subjects are treated in the same attractive manner. It is true that a carefully written introduction deals with the working of the plant, or, in other words, physiological botany; but, when dealing with the types chosen, much information of a more general character is introduced, as we had occasion to mention. We are told, for instance, that the colour of the ribbon of the Legion of Honour was taken from the poppy by the Empress Charlotte of Austria; Tamarisk is so called because it abounds near the River Tamaris, in Spain; there was a superstition that, if the sap of Dogwood were absorbed in a handkerchief on St. John's Night, it would secure the fulfilment of every wish.

The illustrations are as good as those in the first volume. two of the photographic ones we are permitted to reproduce here (see Figures 394 and 395). In the diagram labelled "Figure 3" a plant, which has been ringed, is shown with the leaf above the ring flaccid. The incision as shown is, however, so slight that it would appear only to have penetrated the bark. To cut off the water supply, it would need to go through that part of the wood which is still conveying water. A third volume will complete the work.

W. M. W.

CHEMISTRY.

Notes on Elementary Inorganic Chemistry.—By F. H. JEFFERY, M.A. 55 pages. 8¾-in. × 6-in.

(The Cambridge University Press. Price 2/6 net.)

These brief notes, forming a lecturer's headings, are essentially a compact skeleton, which it is intended that the learner shall clothe. They embody summaries of facts and reactions, which the student will meet in the course of his first steps, and may usefully be made the basis of a preliminary training in the theory of analytical chemistry. They will require supplementing, however, by the teacher or a chemical handbook. The book is well printed, with section headings in bolder type, but it has a fault which no book should possess—it lacks an index.

C. A. M.

HISTORY.

The War in the Peninsula.—Some Letters of Lieutenant Robert Knowles, of the Royal Fusiliers, a Lancashire Officer.—Arranged and annotated by his great-great-nephew, SIR LEES KNOWLES, Bart. 92 pages. 1 plate. 4 maps. 8-in. × 5½-in.

(Simpkin, Marshall & Co. Price 2/6.)

At the present time, when we are continually hearing what soldiers serving with the British Expeditionary Force have to say, there is a particular interest about the letters which were written a hundred years ago by a young Militia officer, Robert Knowles, who volunteered for active service with the 7th Fusiliers in Spain during the Peninsular War. Many things have changed since then: postal arrangements are very different, and the wounded are not left without money to perish from want, but the bravery of British soldiers is the same as it was then.

One of the most striking descriptions in the book is that of the Siege of Badajoz. During this Lieutenant Knowles and his men were the first to capture part of the defences, namely, Fort St. Roque. The officer's sword was broken into a hundred pieces, and his hand was bruised, but otherwise he was unhurt. At Salamanca, however, he received a musket-ball in his left arm, and some months later, when he rejoined his regiment, after acting as Adjutant for some time, he was unfortunately killed in the Mandechari Pass. We congratulate Sir Lees Knowles, his great-great-nephew, on the publication of the Letters, and on the way in which he has connected them together with explanatory matter.

W. M. W.

HISTORY OF SCIENCE.

Roger Bacon Essays. Contributed by various writers on the occasion of the Commemoration of the Seventh Centenary of his Birth. Collected and Edited by A. G. LITTLE. 426 pages. 6 figures.

(The Oxford University Press. Price 16/- net.)

There is some doubt as to the date of Roger Bacon's birth, but 1214 is the most probable year, and the present year, therefore, has been chosen to do due honour to his memory. Remembered for long merely as a magician, he has now been given his rightful position in the history of science as the first to realise the true nature of scientific method as a synthesis of mathematics and experiment. The volume under review is one more evidence of the growing recognition of the value of the history of science, a knowledge of which is essential to a complete understanding of science as it is to-day.

Fourteen essays—eight in English, two in French, and four in German—are here contributed, dealing with different aspects of Roger Bacon's life, work, and influence. The volume opens with an excellent "Life" by the Editor, Mr. A. G. Little, M.A. The chief new point brought to light is that Bacon was not imprisoned during the years 1256–66, as is usually supposed, but was ill, the mistake having arisen through a misunderstanding of a passage in the "Opus Tertium." This is followed by an essay, dealing with the influence of Grosseteste on the direction of Bacon's studies, by Dr. Ludwig Baur; whilst in the next essay M. François Picavet deals with Bacon's position amongst other philosophers of the thirteenth century. The fourth essay, which is by Cardinal Gasquet, is entitled "Roger Bacon and the Latin Vulgate." Cardinal Gasquet points out the importance in which Bacon held the necessity of Biblical revision and the firm grasp he had of the principles of the whole subject. Bacon's philology and mathematics fall for treatment in the next two essays, contributed respectively by Dr. S. A. Hirsch and Professor D. E. Smith. As the latter writer points out, it is not in the extent of his knowledge of mathematics, but in his grip of its principles as applied to science, that Bacon's claim lies to be considered a great mathematician. Bacon's physics are dealt with in the next four essays by Drs. E. Wiedemann, S. Vogl, J. Würschmidt, and Professor Pierre Duhem. Then follows an essay on his relations to alchemy and chemistry by Mr. M. M. P. Muir. There is an error in this essay on page 313, when the author writes: "In 'De Arte Chymiae,' he [Bacon] regards silver as a kind of lead burdened by imperfections." The words "silver" and "lead" should here be transposed. Moreover, the claim made for Bacon by Mr. Muir, that "the method of observation and experiment, and reasoning on the results obtained, . . . led him to the invention of instruments of much usefulness in optics, astronomy, and other branches of physical science," is surely one that goes beyond the facts. Bacon's speculations as to the marvels that might be accomplished by science and art can hardly be called inventions. In many respects, however, this essay is particularly interesting, especially as concerns its criticism of the alchemistic doctrine of "primary matter," and its prevalence nowadays in a disguised form. The following essay, by Lieut.-Colonel H. W. L. Hime, entitled "Roger Bacon and Gunpowder," is taken from the author's "Gunpowder and Ammunition" (though this is not stated in the present volume). It brings forward evidence for believing Bacon to have been the discoverer of gunpowder, and attempts a solution of the cryptogram in which, it is believed, he concealed this discovery. The next essay, by Mr. E. Withington, deals with Bacon's medical knowledge and views, and is followed by one, by Sir J. E. Sandys, entitled "Roger Bacon and English Literature."

The volume closes with a bibliography contributed by the Editor. It forms a most interesting and instructive work, of great value to all students of the history of science.

H. S. REDGROVE.

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NOTICES.

LONDON COUNTY COUNCIL LECTURES.—The following is a list of the free lectures which will be given during the month of November at the Horniman Museum, Forest Hill, S.E., at 3 o'clock: 7th, "Fossils and how they are Formed," Mr. E. A. Martin, F.G.S.; 14th, "The Folk-lore of Deep-sea Fishing," Mr. Edward Lovett; 21st, "The Origin and History of Bells," Mr. A. R. Wright; 28th, "Colours and Markings of Animals, II," Mr. H. N. Milligan.

THE ROYAL PHOTOGRAPHIC SOCIETY.—On Wednesday, October 21st, there was opened at 35, Russell Square, a House Exhibition of Photographs by Mr. Lewis Balfour, of "Bird Life on the Bass Rock." There are upwards of one hundred of these pictures, showing the various sea birds and incidents in their lives. The public will be admitted free daily, from 11 a.m. till 5 p.m., until Saturday, November 28th.

THE MANCHESTER SCHOOL OF TECHNOLOGY.—The School possesses particulars of more than five hundred and fifty students who were in attendance at the College during the academic year 1913–14, and who are now serving in various branches of His Majesty's Forces. With a view to the completion of a Roll of Honour, which shall also include the names of past students engaged upon military service, the Registrar will be glad to receive any information from such persons themselves or from their relatives or friends.

MR. MURRAY'S QUARTERLY LIST.—Among the forthcoming works announced in Mr. Murray's List we find the following, which will be of special interest to our readers: "A Hunter-Naturalist in the Brazilian Wilderness," by Theodore Roosevelt; "Emma Darwin (Mrs. Charles Darwin): A Century of Family Letters, 1792-1896," edited by her daughter, Henrietta Litchfield. The work includes letters by Mrs. Charles Darwin's mother, and the second volume contains many unpublished letters of Charles Darwin; "Trees and Shrubs Hardy in the British Isles," by W. J. Bean; and "Life Histories of American Game Animals," by Theodore Roosevelt and Edmund Heller.

POULTRY-LAYING COMPETITION.—The Utility Poultry Club have issued the result of the poultry-laying competition which has been carried out at the Harper Adams Agricultural College, Newport, Salop. The records for the six leading pens are as follows:—

Order.	Pen No.	Breed.	Total for 11 months. Eggs.	Value. £	s.	d.
1	6	White Wyandottes	1173	6	6	8¼
2	38	White Leghorns	1207	6	3	10¾
3	18	White Wyandottes	1084	6	0	10¾
4	2	White Wyandottes	1198	6	0	9½
5	39	White Leghorns	1179	6	0	3
6	35	White Leghorns	1186	5	18	8¾

THE ZOOLOGICAL SOCIETY'S GARDENS.—The registered additions to the Society's Menagerie during the month of September were one hundred and thirty in number. Of these fifty-six were acquired by presentation, fifty-one by purchase, eleven were received on deposit, six in exchange, and six were born in the Gardens. The following may be specially mentioned: One White-bearded Gnu (*Connochaetes albojubatus*), born in the Menagerie on September 28th; two Grey-tailed Fruit-Pigeons (*Osmotreron griseicauda*), from Java, new to the collection, presented by the Marquess of Tavistock, F.ZS., on September 18th. A collection of birds from New Guinea, the Aru Islands, and so on, acquired by purchase on September 11th, and containing Greater Birds-of-Paradise (*Paradisea apoda*), a Lesser Bird-of-Paradise (*P. minor*), King Birds-of-Paradise (*Cicinnurus regius*), and the following species new to the collection: One Fairy Bluebird (*Irena turcosa*), from Java; two Blue-eyed Ravens (*Macrocorax fuscicapillus*); one New Guinea Pitta (*Pitta novae-guineae*); three Duperrey's Megapodes (*Megapodius duperreyi*), from the Aru Islands; and two Pied Egrets (*Notophoyx flavirostris*), from South-west New Guinea.

THE SCHOOL GARDEN MONTHLY.—From Dublin comes the first number of *The School Garden Monthly*, which will devote its efforts to promoting school gardening in Ireland. It is intended to inculcate a desire to improve the home surroundings, to provide healthful exercise for the body and mind, to train the young scholar in the first principles of citizenship by giving him the responsibility of ownership and respect for public property, and for the rights of others, while throughout and at all times to keep him in intimate touch with Nature as the ultimate source of all knowledge and beauty of the world. There is every reason why teachers in England should take advantage of this paper. The botanical side will be watched over by Mr. David Houston, well known for his pioneer work in Essex; Professor Henry will deal with trees; Professor Grenville Cole will write on the physical features of the country and on soils; and Professor Carpenter on zoölogical subjects. The practical gardening will be looked after by the School Gardening experts of the Irish Department. The price of the journal is one penny monthly (publishing office, 12, D'Ollier Street, Dublin). It is well illustrated and printed, and the first number contains: "The Story of a Bulb," articles on "The Garden and the Countryside in October," an illustrated account of a "School Garden," and Notes on Vegetables for Winter and Spring, as well as the Planting of Fruit Trees. The last page is headed "Playtime," and appeals strongly to young people.

THE ALCHEMICAL SOCIETY.—The fourteenth General Meeting of the Alchemical Society was held at 1, Piccadilly Place on Friday, October 9th, at 8.15 p.m., when the Honorary President, Professor John Ferguson, LL.D., and so on, of Glasgow University, delivered his presidential address for the session, dealing with the work entitled "The Marrow of Alchemy." The work, said Professor Ferguson, a poem in two parts or seven books, appeared in London in 1854–55 in a small octavo volume. The authorship is usually ascribed to George Starkey, who is said to have been a native of Bermuda, a graduate in arts, and a practitioner in medicine and pharmacy, though there is some doubt as to whether he really wrote it. The poem professes to give an insight into the mode of transmutation of "base" metals into silver and gold. The author first tries to prove that metals grow from seeds, and then relates some of his own experiences in alchemy, following this up by a so-called "pedigree" of the metals. The second part of the book contains practical directions concerning furnaces and other apparatus, the material to be employed, and so on, under confused symbolic names, closing with a sort of recapitulation. But, with all the help possible, it is not easy to see how the multiplication of precious metal is effected, or even what is obtained; and the lecturer suggested that, if the subject of the book were stated in the ordinary language of chemistry, it would probably be found that all the reactions are familiar, and that the gold apparently obtained was only the gold used in preparing the so-called philosopher's stone, and that the deep, enshrouding mystery was due to the operator not knowing what he was doing.